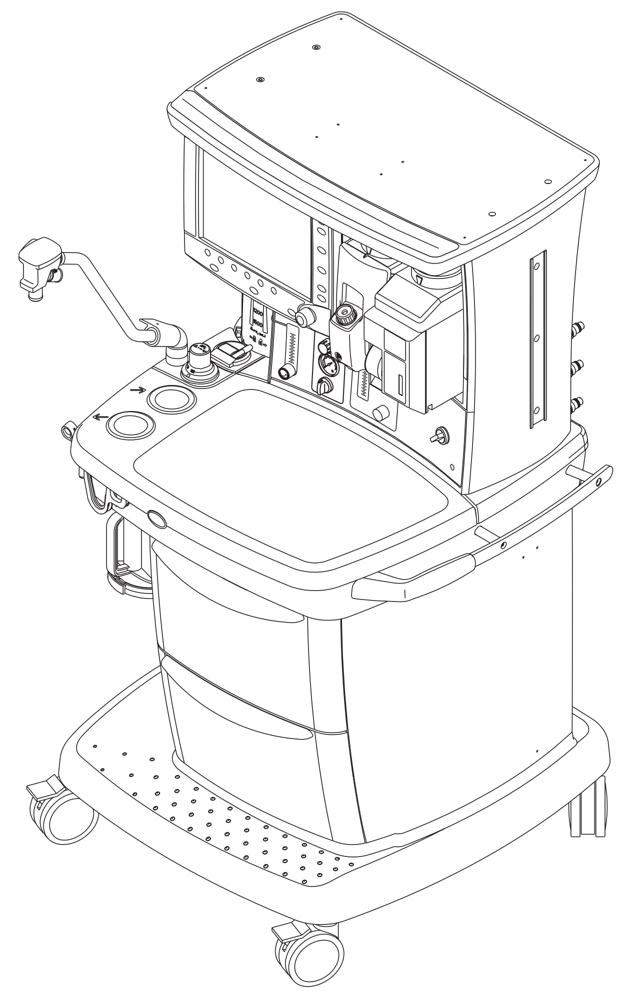
Avance Anesthesia Machine
Technical Reference Manual



Datex-Ohmeda products have unit serial numbers with coded logic which indicates a product group code, the year of manufacture, and a sequential unit number for identification. The serial number can be in one of two formats.

AAA**X**11111	AAA**XX**111111AA
The **X** represents an alpha character indicating the year the product was manufactured; **H** = 2004, **J** = 2005, etc. **I** and **O** are not used.	The **XX** represents a number indicating the year the product was manufactured; **04** = 2004, **05** = 2005, etc.

09/07 1009-0357-000

Avance Anesthesia Machine

Machines with the original display unit (DU)
with System Software 3.2 or earlier

Machines with the high performance display unit (HPDU)
with System Software 4.X or greater

Important

The information contained in this Technical Reference manual pertains only to those models of products which are marketed by Datex-Ohmeda as of the effective date of this manual or the latest revision thereof. This Technical Reference manual was prepared for exclusive use by Datex-Ohmeda service personnel in light of their training and experience as well as the availability to them of parts, proper tools and test equipment. Consequently, Datex-Ohmeda provides this Technical Reference manual to its customers purely as a business convenience and for the customer's general information only without warranty of the results with respect to any application of such information. Furthermore, because of the wide variety of circumstances under which maintenance and repair activities may be performed and the unique nature of each individual's own experience, capacity, and qualifications, the fact that customer has received such information from Datex-Ohmeda does not imply in anyway that Datex-Ohmeda deems said individual to be qualified to perform any such maintenance or repair service. Moreover, it should not be assumed that every acceptable test and safety procedure or method, precaution, tool, equipment or device is referred to within, or that abnormal or unusual circumstances, may not warrant or suggest different or additional procedures or requirements.

This manual is subject to periodic review, update and revision. Customers are cautioned to obtain and consult the latest revision before undertaking any service of the equipment. Comments and suggestions on this manual are invited from our customers. Send your comments and suggestions to the Manager of Technical Communications, Datex-Ohmeda, Ohmeda Drive, PO Box 7550, Madison, Wisconsin 53707.

⚠ CAUTION Servicing of this product in accordance with this Technical Reference manual should never be undertaken in the absence of proper tools, test equipment and the most recent revision to this service manual which is clearly and thoroughly understood.

Technical Competence

The procedures described in this Technical Reference manual should be performed by trained and authorized personnel only. Maintenance should only be undertaken by competent individuals who have a general knowledge of and experience with devices of this nature. No repairs should ever be undertaken or attempted by anyone not having such qualifications.

Datex-Ohmeda strongly recommends using only genuine replacement parts, manufactured or sold by Datex-Ohmeda for all repair parts replacements.

Read completely through each step in every procedure before starting the procedure; any exceptions may result in a failure to properly and safely complete the attempted procedure.

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1 Introduction

In this section This section provides a general overview of the Avance anesthesia machine.

1.1 What this manual includes

This manual covers the service information for the S/5 Avance line of anesthesia machines. It covers the following components:

- Display Unit
- Integral electronics
- Gas delivery components
- Breathing system components
- Frame component
- Optional suction regulator
- Optional auxiliary O_2 flowmeter

Other equipment

Other equipment may be attached to the system on a display mount, the top shelf, or on the side dovetail rails. Consult separate documentation relative to these items for details.

1.2 User's Reference manuals

Some sections of this manual refer you to the User's Reference manual for the S/5 Avance. To expedite repairs, you must have, and be familiar with, the User's Reference manuals for this product.

Refer to the S/5 Avance User's Reference manual if you need further information about the operation of the system.

1.3 What is an Avance anesthesia machine?

The Avance anesthesia system combines advanced anesthesia delivery, patient monitoring, and care information management in a contemporary, compact design. The system features electronic gas mixing for up to three gases.

Optional, integrated features include auxiliary O_2, suction control, and gas monitoring (E- and M-Series respiratory gas module capable).

The Avance system uses SmartVent ventilation technology offering Volume Control Ventilation with tidal volume compensation, Pressure Control Ventilation, and electronic PEEP. The proven SmartVent also features optional Pressure Support Ventilation with an Apnea Backup (PSVPro) that is used for spontaneously breathing patients, Synchronized Intermittent Mandatory Ventilation (SIMV) modes, Pressure control ventilation-volume guarantee (PCV-VG), and VCV cardiac bypass.

The Avance system is not suitable for use in a MRI environment.

Note Configurations available for this product depend on local market and standards requirements. Illustrations in this manual may not represent all configurations of the product.

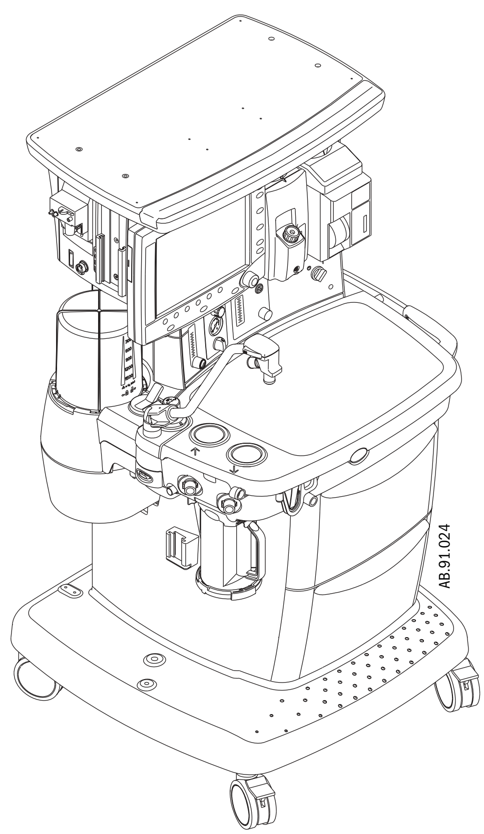
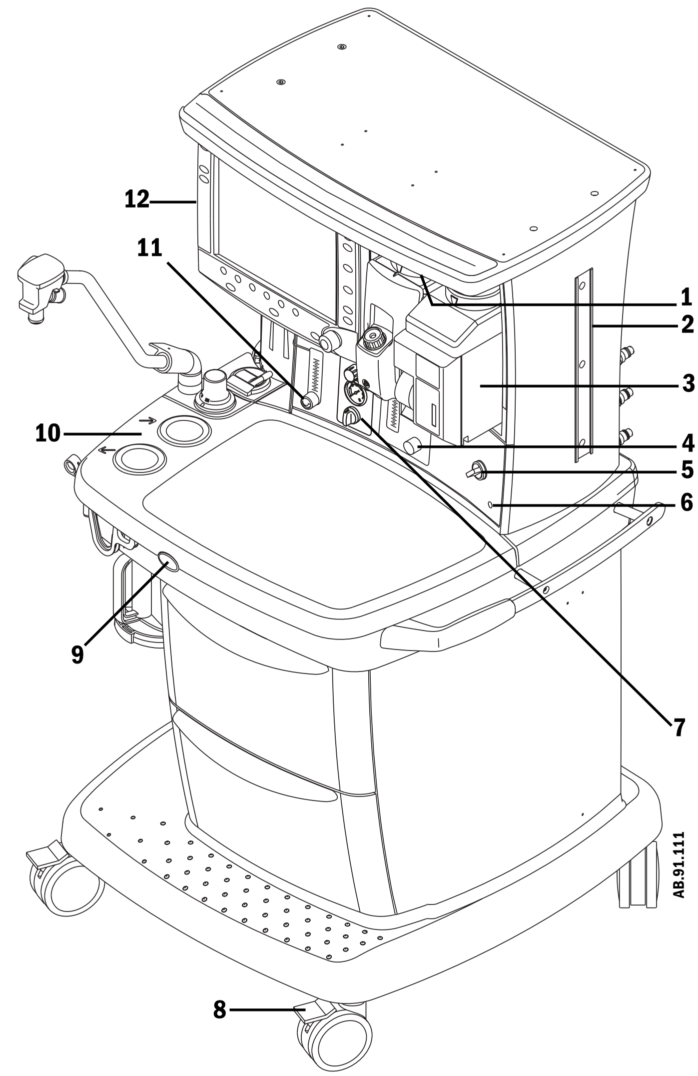


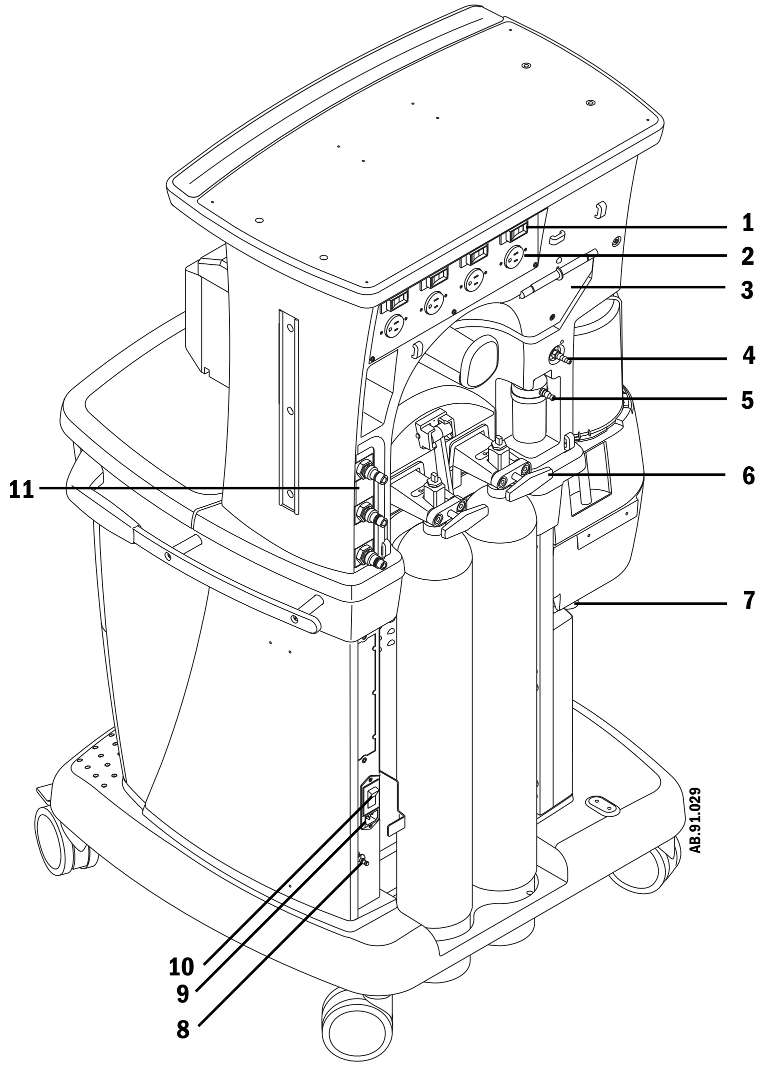
Figure 1-1 ▪ S/5 Avance system

1.4 Anesthesia system components



1. Light switch
2. Dovetail/GCX rails
3. Vaporizer
4. Alternate O_2 control
5. System switch
6. Mains indicator
7. Integrated suction (optional)
8. Brake
9. O_2 flush button
10. Advanced breathing system
11. Auxiliary O_2 flow control (optional)
12. Anesthesia display

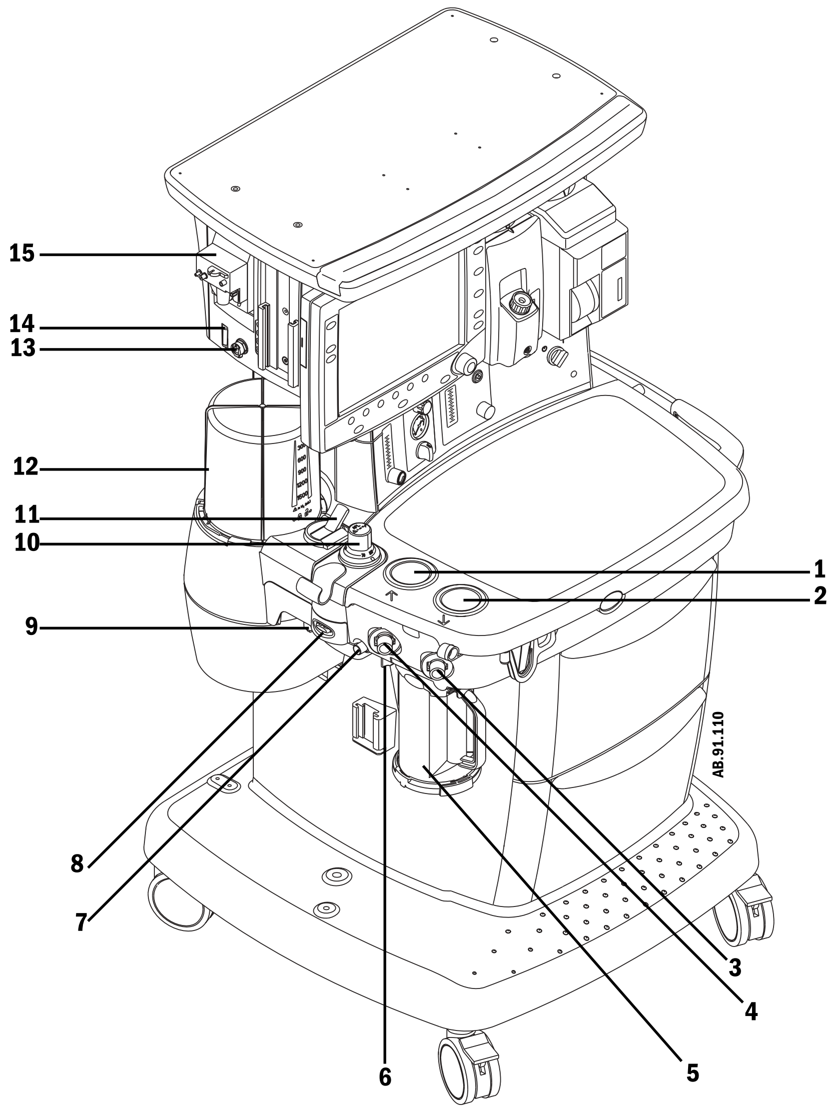
Figure 1-2 • Front view



1. Outlet circuit breaker
2. Isolated electrical outlet (optional)
3. Cable access door
4. Vacuum connection
5. Collection bottle connection
6. Cylinder yoke
7. AGSS (Anesthesia Gas Scavenging System)
8. Equipotential stud
9. Mains inlet
10. System circuit breaker
11. Pipeline connections

Figure 1-3 • Rear view

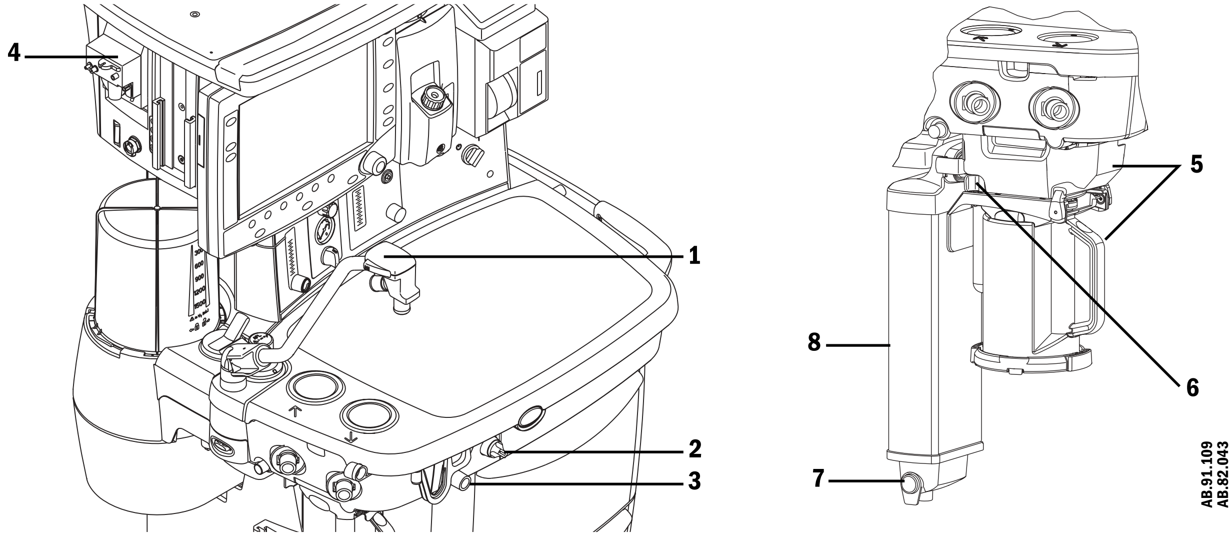
1.5 Breathing system components



1. Expiratory check valve
2. Inspiratory check valve
3. Inspiratory flow sensor
4. Expiratory flow sensor
5. Absorber canister
6. Absorber canister release
7. Leak test plug
8. Breathing system release
9. Manual bag port
10. Adjustable pressure-limiting (APL) valve
11. Bag/Vent switch
12. Bellows assembly
13. Sample gas return port
14. AGSS indicator (only present on some AGSS versions)
15. Airway module (optional)

Figure 1-4 • Breathing system

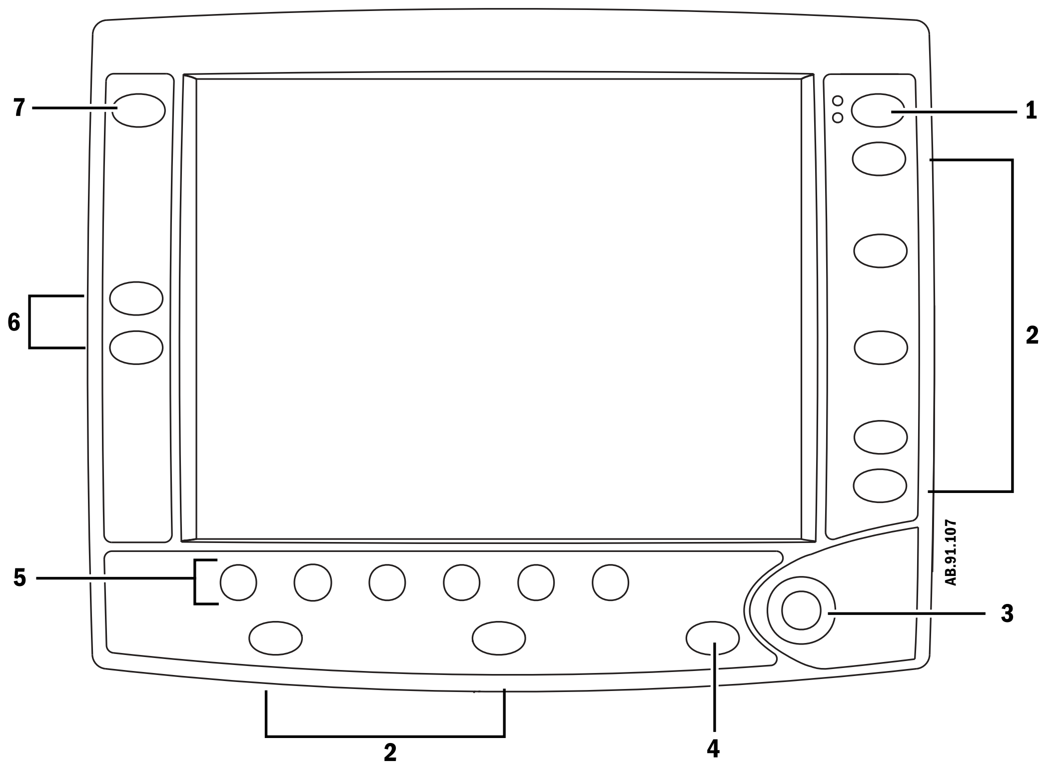
1.5.1 Optional ABS components



1. Bag support arm
2. Auxiliary Common Gas Outlet (ACGO) switch
3. ACGO port
4. Airway module
5. EZchange Canister system (CO_2 Bypass)
6. EZchange Canister release
7. Condenser drain button
8. Condenser

Figure 1-5 • Breathing system options

1.6 Display controls



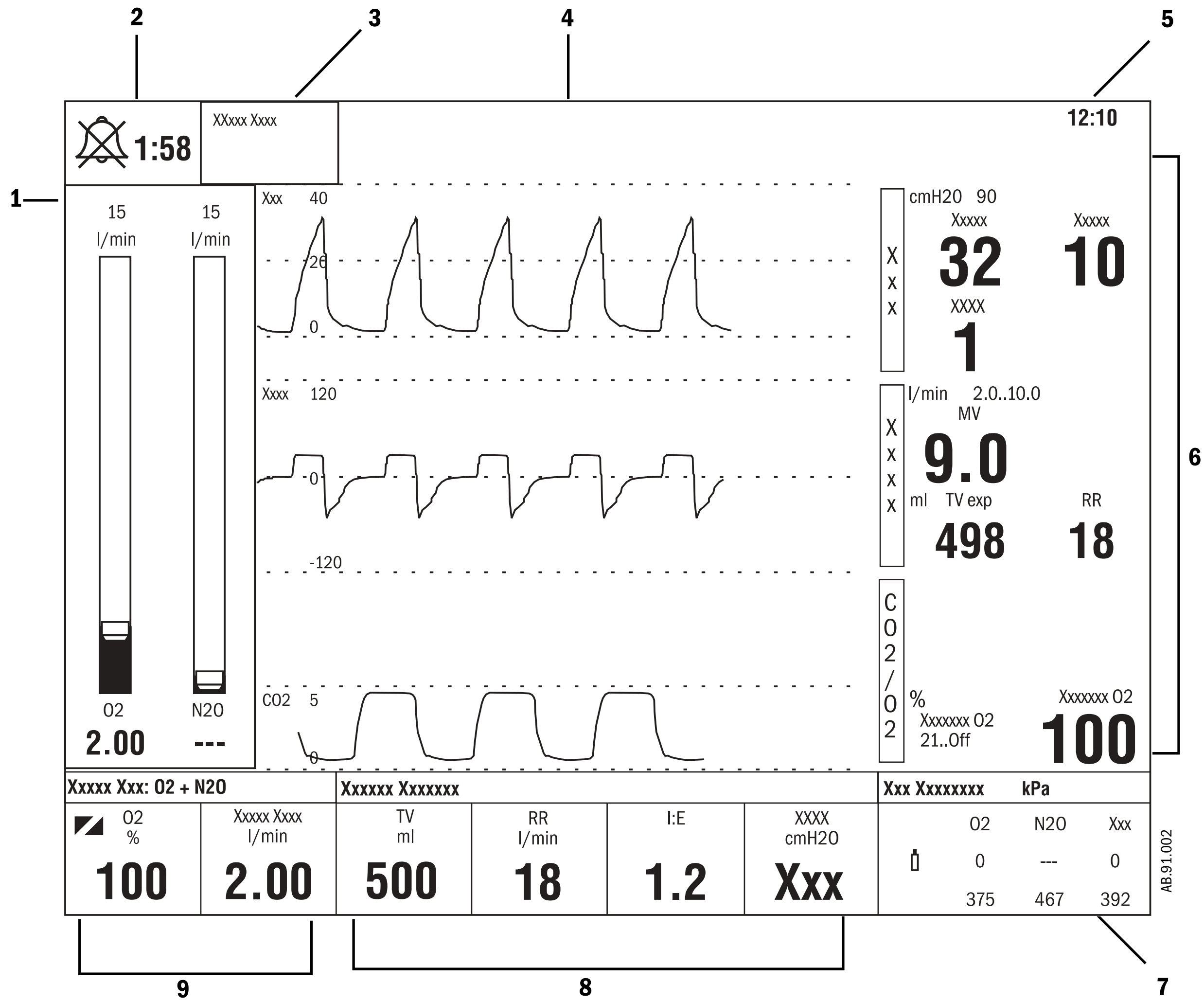
1.	Silence Alarms key	Push to silence any active, silenceable high and medium priority alarms or to suspend/acknowledge any non-active medium or high priority alarms. Alarm is silenced for 120 seconds or alarm is suspended for 90 seconds.
2.	Menu keys	Push to show corresponding menu.
3.	ComWheel	Push to select a menu item or confirm a setting. Turn clockwise or counterclockwise to scroll menu items or change settings.
4.	Normal Screen key	Push to remove all menus from the screen.
5.	Quick keys	Push to change corresponding gas setting or ventilator setting. Turn the ComWheel to make a change. Push the ComWheel to activate the change.

HPDU only

6.	Timer keys	Push to start or stop the timer. Push to reset the timer back to zero.
7.	MV/TV Alarms key	Push to turn off the MV and TV alarms. Push again to turn the MV and TV alarms back on.

Figure 1-6 • Ventilator controls

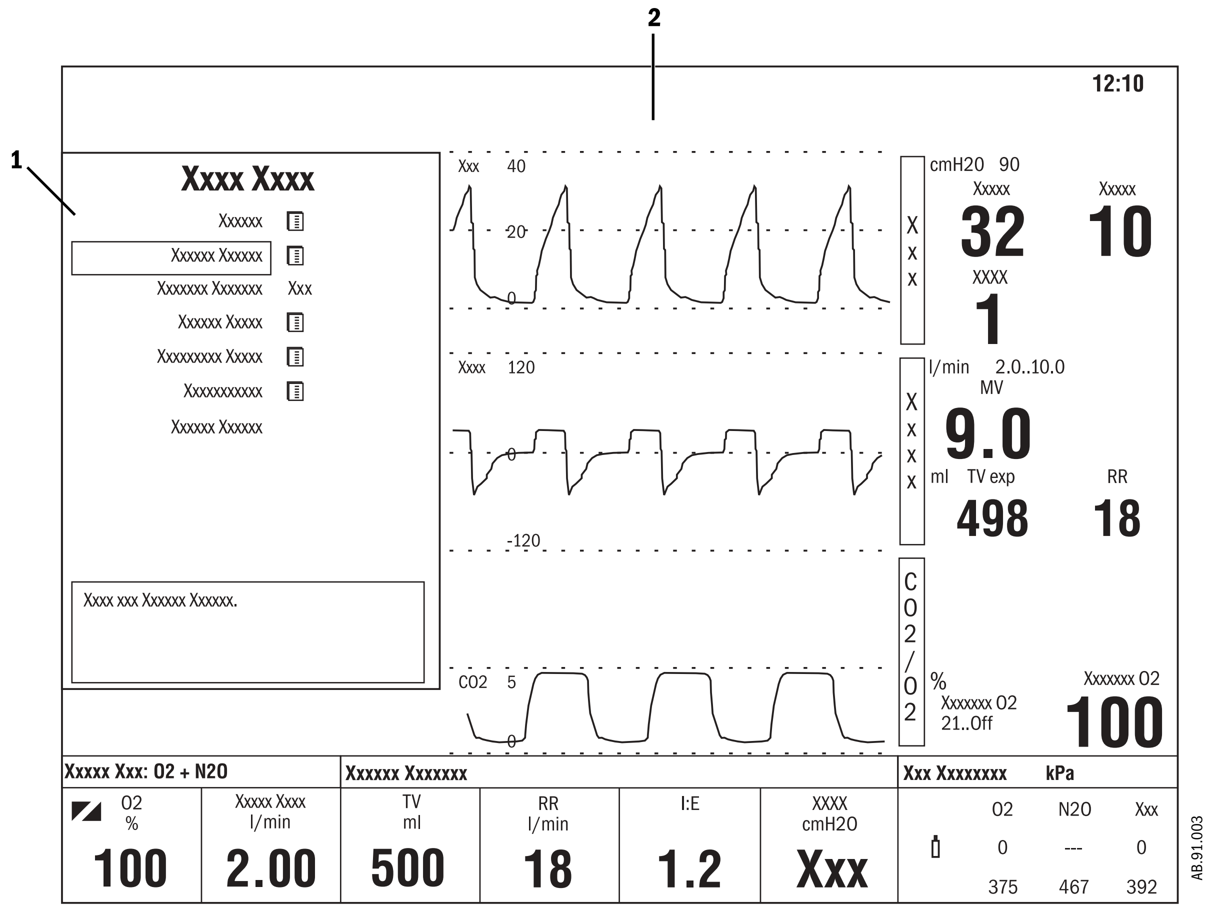
1.7 Anesthesia system display



1. Electronic gas flow tubes
2. Alarm silence countdown
3. Alarm message fields
4. Waveform field
5. Clock
6. Number field
7. Free number display
8. Ventilator settings
9. Gas settings

Figure 1-7 • Normal view

When a menu key is selected, the menu field overlays the gas flow tubes and the waveform fields start at the right edge of the menu.

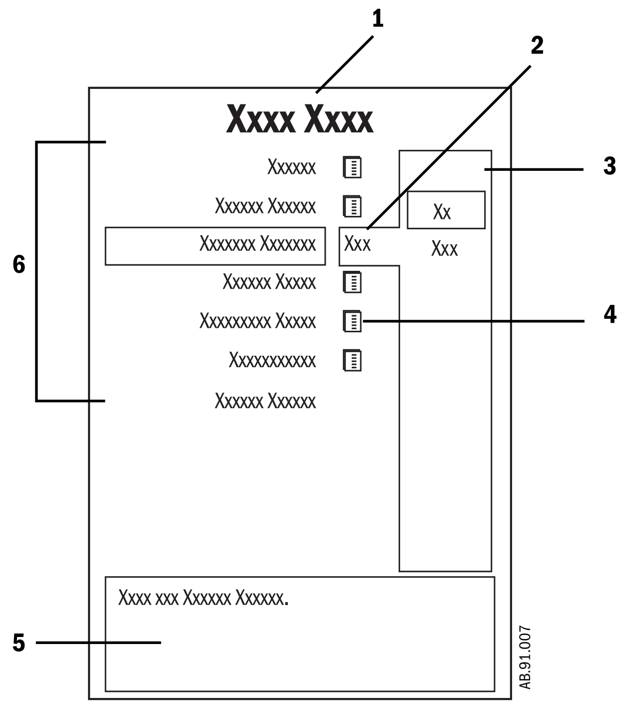


1. Menu
2. Waveform fields

Figure 1-8 • Menu view

1.7.1 Using menus

Push a menu key to display the corresponding menu. Use the ComWheel to navigate through the menu.



1. Menu title
2. Present selection
3. Adjustment window
4. Indicates submenu
5. Short instructions
6. Menu selections

Figure 1-9 • Example menu

1. Push the menu key to display the corresponding menu.
2. Turn the ComWheel counterclockwise to highlight the next menu item. (Turn the ComWheel clockwise to highlight the previous menu item.)
3. Push the ComWheel to enter the adjustment window or a submenu.
4. Turn the ComWheel clockwise or counterclockwise to highlight the desired selection.
5. Push the ComWheel to confirm the selection.
6. Select ***Normal Screen*** or push the **Normal Screen** key to exit the menu and return to the normal monitoring display. (Select ***Previous Menu*** to return to the last displayed menu, if available.)

1.8 Symbols used in the manual or on the equipment

Symbols replace words on the equipment, on the display, or in Datex-Ohmeda manuals. No one device or manual uses all of the symbols.

Warnings and Cautions tell you about dangerous conditions that can occur if you do not follow all instructions in this manual:

- Warnings tell about a condition that can cause injury to the operator or the patient.
- Cautions tell about a condition that can cause damage to the equipment.

Read and follow all warnings and cautions.

On (power)

Off (power)

Standby

Standby or preparatory state for part of the equipment

“ON” only for part of the equipment

“OFF” only for part of the equipment

Direct current

Alternating current

Protective earth ground

Earth ground

Frame or chassis ground

Equipotential

Alarm silence

Alarm silence

Type B equipment

Type BF equipment

Type CF equipment

Caution, ISO 7000-0434

Attention, refer to product instructions, IEC 60601-1

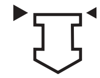
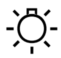
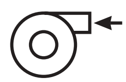
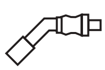
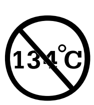
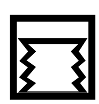
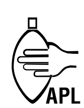
Dangerous voltage

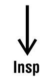
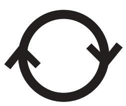
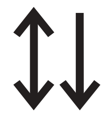
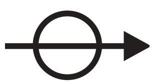
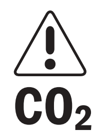
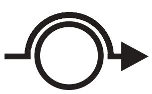
Electrical input

Electrical output

Pneumatic input

Pneumatic output

+	Plus, positive polarity	→	Movement in one direction
-	Minus, negative polarity	↔	Movement in two directions
	Variability		Read top of float
	Variability in steps		Read to center of float
	Lamp, lighting, illumination		Vacuum inlet
	This way up		Suction bottle outlet
	Pipeline		Cylinder
	Lock		Isolation transformer
	Unlock		Linkage system
	Close drain		Risk of Explosion.
	Drain (remove condensate)		Low pressure leak test
	Not autoclavable		Mechanical ventilation
134°C	Autoclavable		Bag position/ manual ventilation
⚠ ≈ cmH_2O	APL settings are approximate	**O_2+**	O_2 Flush button

	Inspiratory flow		Expiratory flow
	Inspiratory flow		Expiratory flow
	Pinch hazard		Submenu
	Circle breathing circuit module		Bain/Mapleson D breathing circuit module
	The primary regulator is set to pressure less than 345 kPa (50 psi)		The primary regulator is set to pressure less than 414 kPa (60 psi)
	Absorber on		CO_2 Bypass Option
	Absorber off (CO_2 Bypass active)		EZchange Canister (CO_2 bypass)
	No battery/battery failure		Battery in use. Bar indicates amount of battery power remaining.
REF	Stock Number	MAX	Maximum
SN	Serial Number	℞ ONLY	Caution: federal law prohibits dispensing without prescription.
EC REP	Authorized representative in the European Community	CE xxxx	Systems with this mark agree with the European Council Directive (93/42/EEC) for Medical Devices when they are used as specified in their User's Reference manuals. The xxxx is the certification number of the Notified Body used by Datex-Ohmeda's Quality Systems.
	Date of Manufactur		
	Manufacturer	PCT	GOST R Russian certification

2 Theory of Operation

In this section

2.1 Electrical system

The electrical system consists of two main computing units: the Display Unit and the Anesthesia Control board. Additional subsystems interact with these computing hosts to perform various gas delivery, ventilation, and monitoring functions.

The Display Unit handles the main user interface functions and connections to external devices. The Display Unit software runs on the Windows CE operating system.

Therapy functions are handled by the Anesthesia Control board. The Anesthesia Control board is based on the Motorola Coldfire processor with a Nucleus operating system.

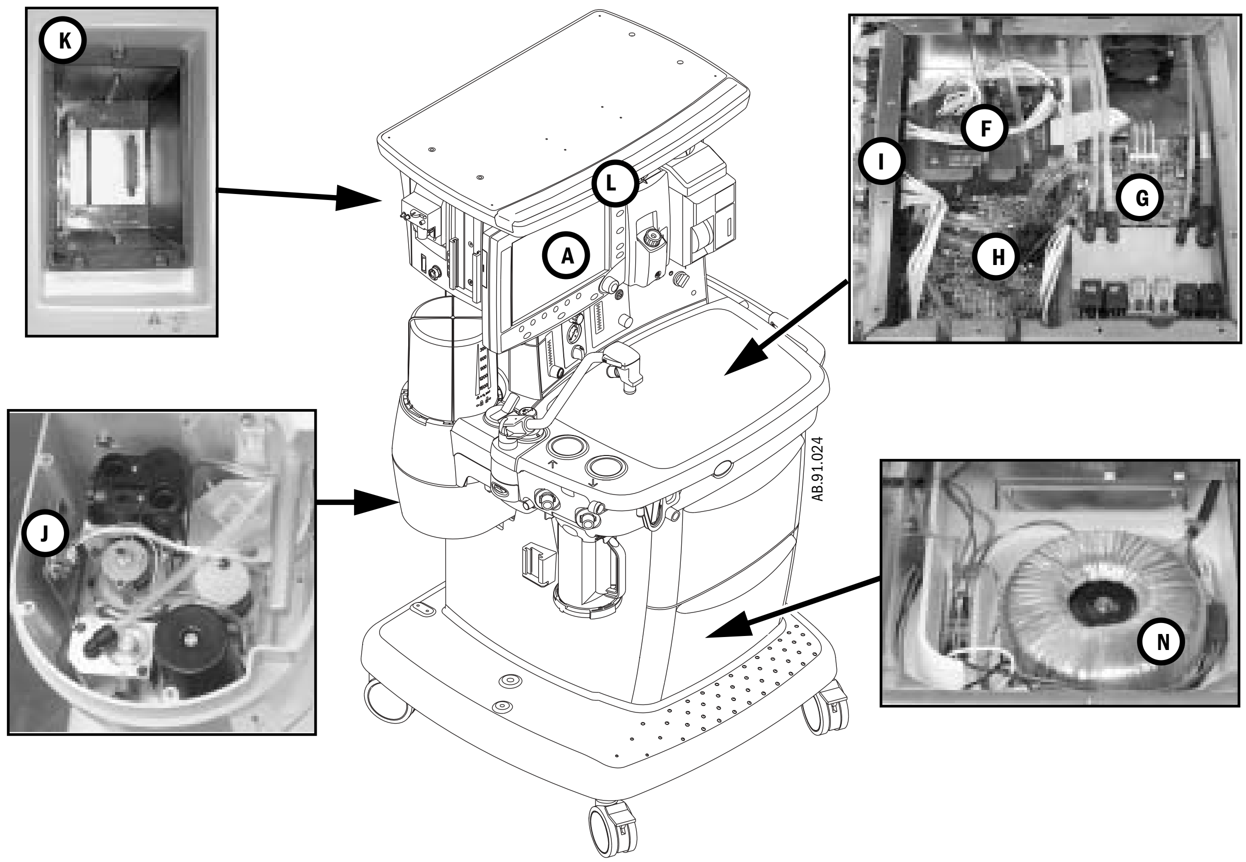
Embedded controllers are used to perform specific machine functions on subsystems like the Power Controller board and the Mixer board.

The processors communicate through serial bus channels.

The various functions of the electrical system are accomplished on the following:

- Display Unit CPU (**A**)
- Display Unit System Interconnect assembly (**B**)
- Display Connector board (**C**)
- Power Control assembly (**D***)
- Anesthesia Control board (**E**)
- Pan Connector board (**F**)
- Electronic Mixer board (**G**)
- Ventilator Interface board (**H**)
- ABS Filter board (**I**)
- Vent Engine Connector board (**J**)
- MGAS Power Supply board (**K**)
- Light Strip board (**L**)
- Inrush board (**M**)
- Toroid (**N**)

* Early production machines use a full-size Power Controller board that includes an on-board AC/DC power supply. Late production machines (or machines serviced with replacement assemblies) use a universal power supply (U-Frame) that feeds into a half-width Power Controller board.


K
L
A
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G
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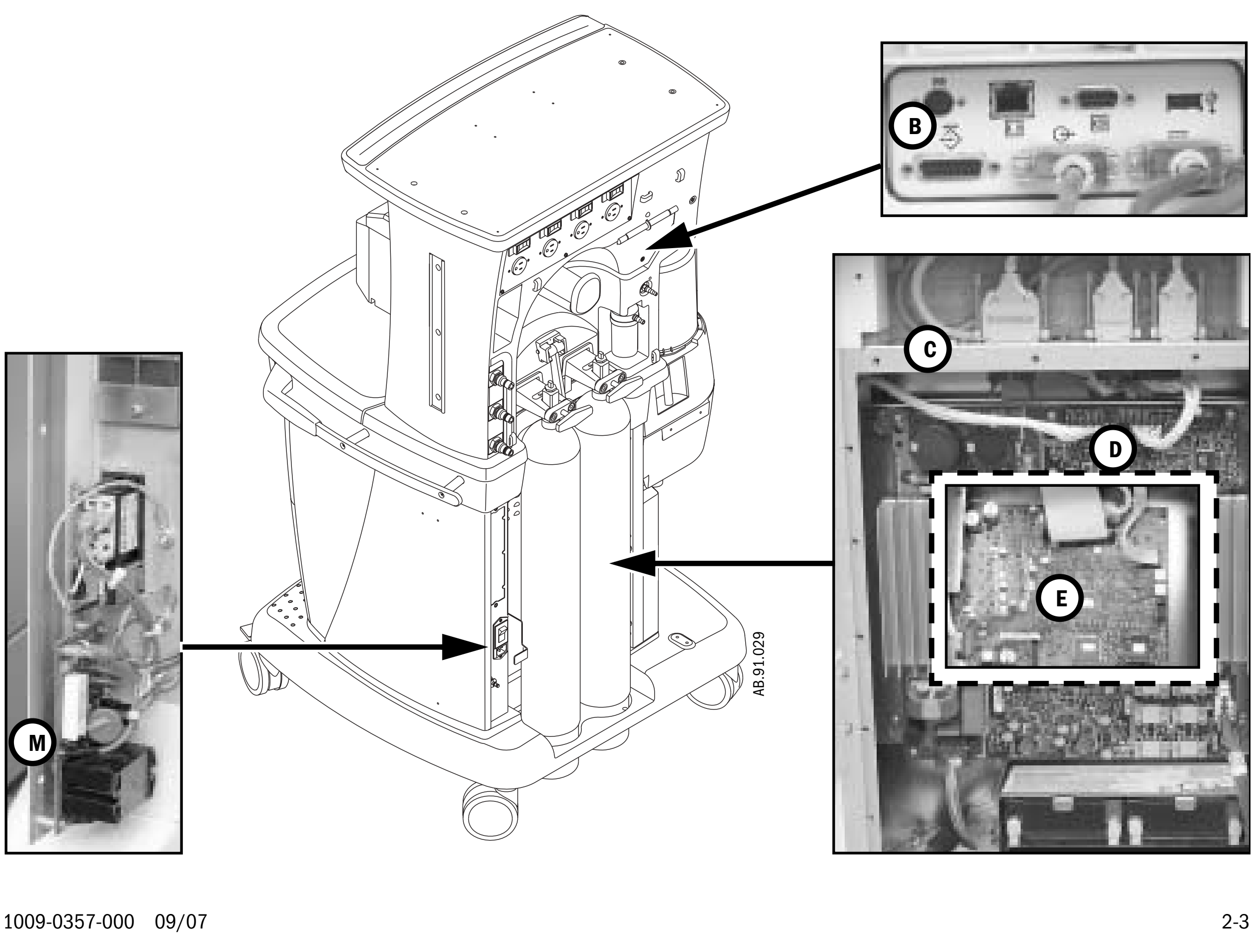
AB.91.024


B
C
D
E
M
AB.91.029

2.2 Power subsystem (original)

Mains power enters the system through the AC Inlet module (**A**), which includes a line filter and the system circuit breaker. Mains power is routed through the Inrush (**B**) circuit board to the isolation transformer (**C**).

The isolated secondary output of the transformer is routed through fuses (**D**) and a second line filter (**E**) to the input of the Power Controller board (**F**). If the system is equipped with electrical power outlets, the transformer (larger size) also supplies isolated power to the electrical outlets through individual circuit breakers.

The Power Controller board interfaces with the system through:

- the Anesthesia Control board connector (**G**),
- the Display Connector board connector (**H**),
- the battery connector (**I**) and fan connector (**J**).

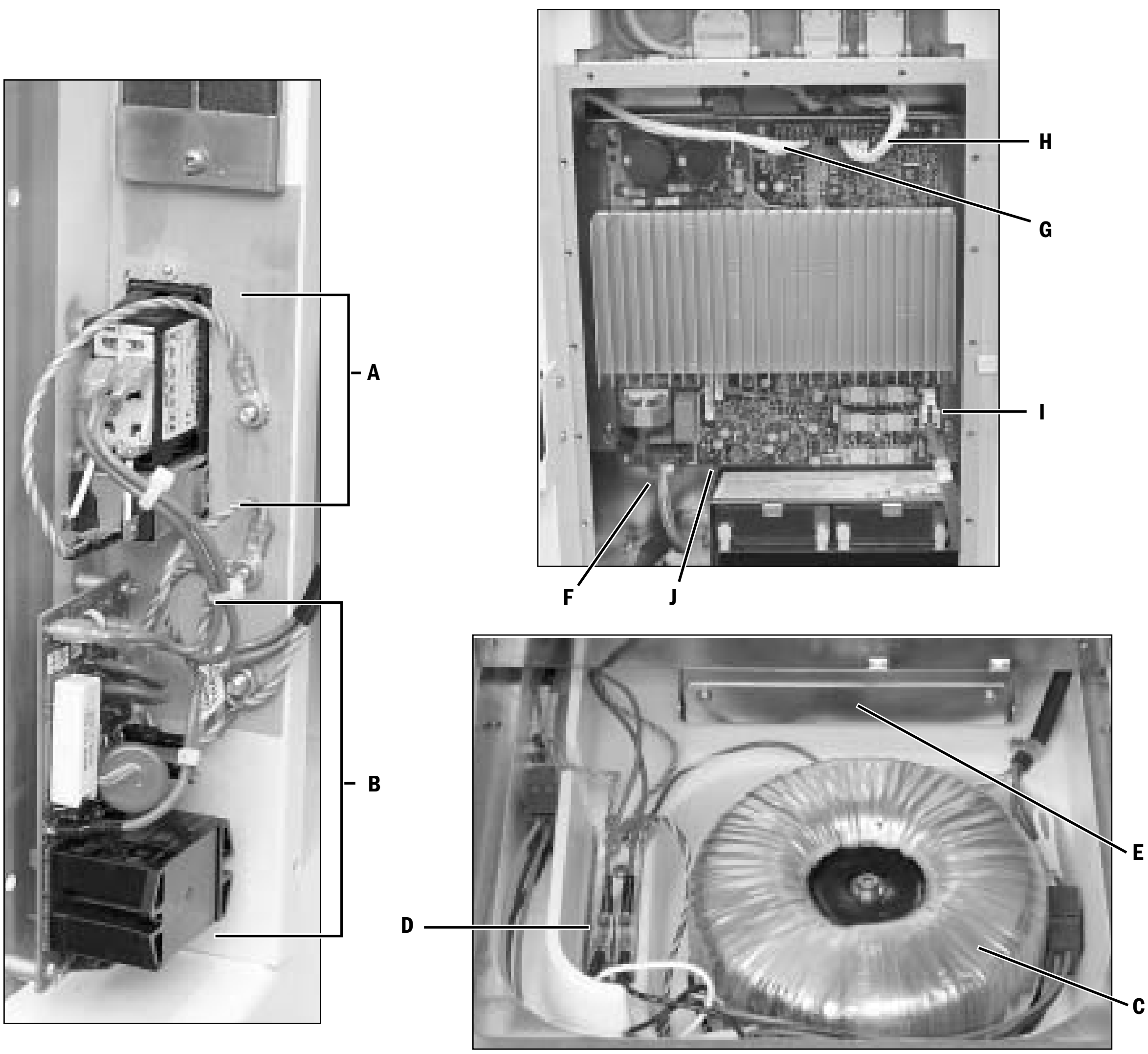


Figure 2-10 • Power subsystem (original)

2.2.1 Power Controller board

The system uses a distributed power bus. The Power Controller board contains:

- an AC/DC converter that converts line voltage to high voltage DC.
- a DC/DC converter that converts the high voltage DC to battery voltage.
- a DC/DC converter that converts battery voltage to the 12.5 VDC system bus voltage.

The Power Controller contains supervisory circuitry that performs:

- battery charge control (battery switch circuits provide a minimum of 30 minutes of system power in the event of AC power failure).
- current, voltage, and temperature monitoring.
- AC sensing.
- fan control.

Two 12-volt batteries, wired in series, provide the back-up power.

The Power Controller communicates with the Display Unit through a RS-422, 9.6 kB channel. It receives the On/Standby signal from the system switch through the Anesthesia Control board.

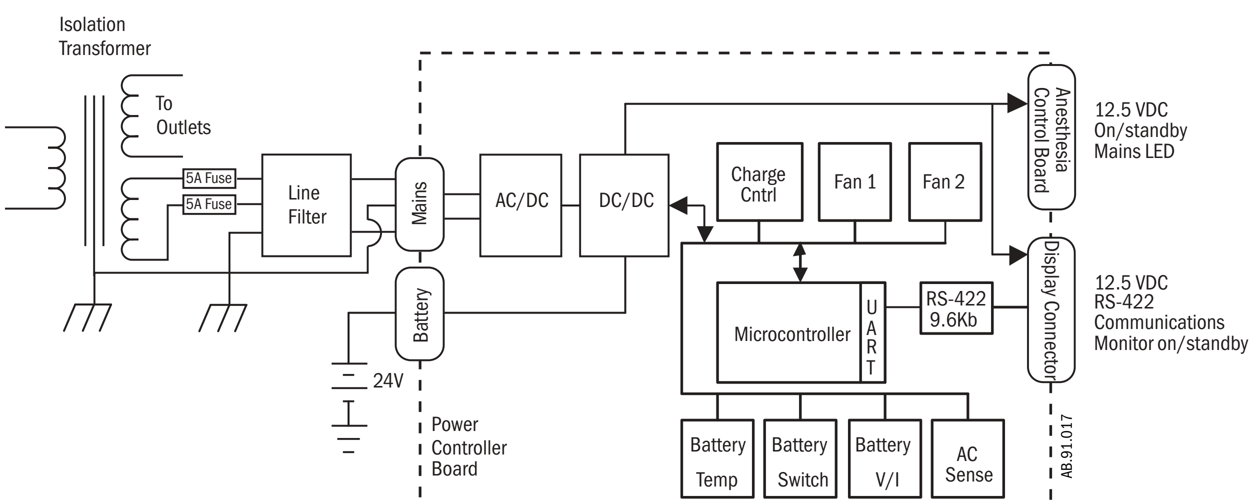


Figure 2-11 • Power subsystem (original)

2.3 Power subsystem (with U-Frame power supply)

Mains power enters the system through the AC Inlet module (**A**), which includes a line filter and the system circuit breaker. Mains power is routed through the Inrush (**B**) circuit board to the isolation transformer (**C**).

The isolated secondary output of the transformer is routed through fuses (**D**) and a second line filter (**E**) to the universal power supply (**F**). The DC output of the power supply feeds into the Power Controller board (**G**). If the system is equipped with electrical power outlets, the transformer (larger size) also supplies isolated power to the electrical outlets through individual circuit breakers.

The Power Controller board interfaces with the system through:

- the Anesthesia Control board connector (**H**),
- the Display Connector board connector (**I**),
- the battery connector (**J**) and fan connector (**K-Fan1**).

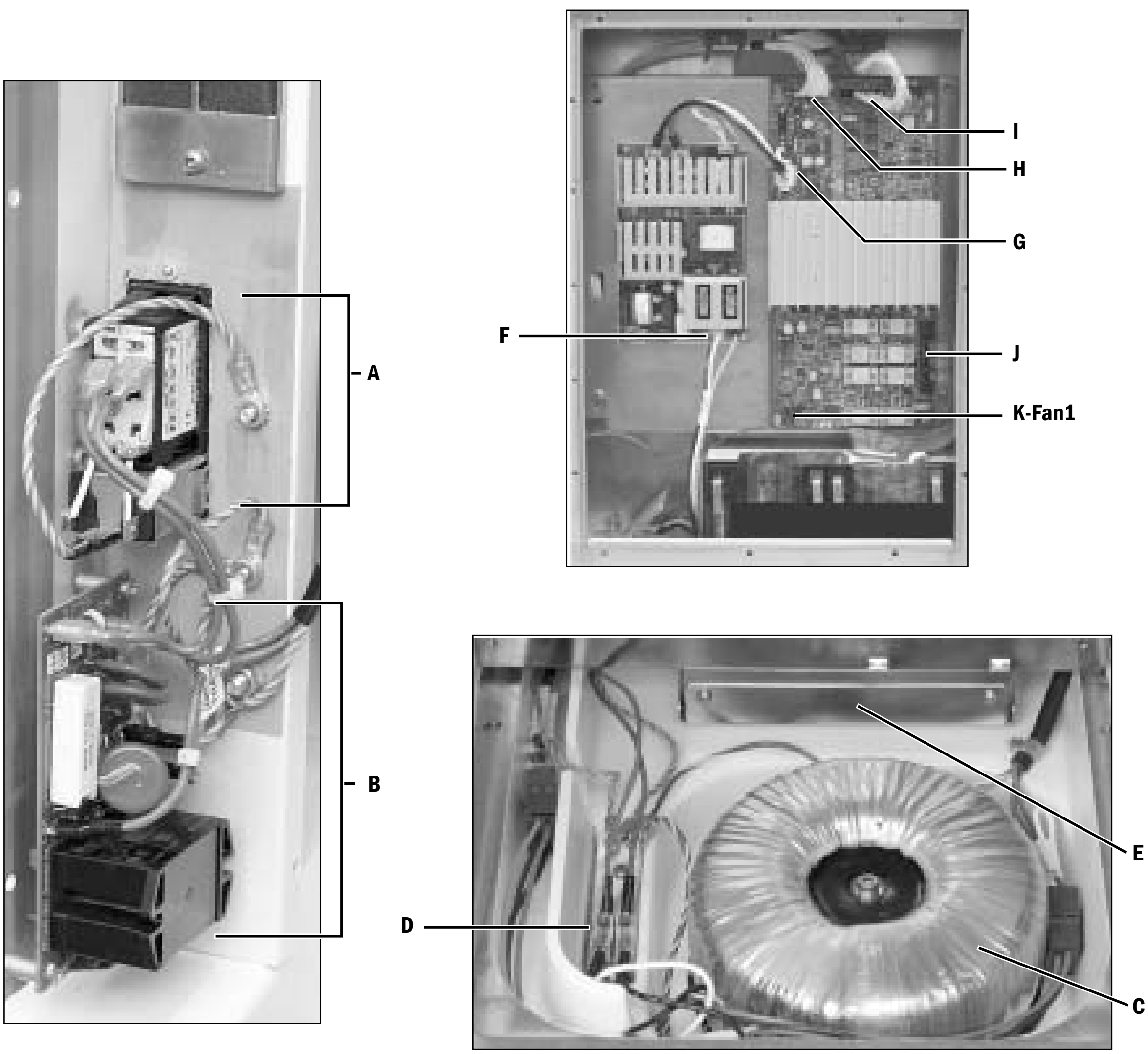


Figure 2-12 • Power subsystem (with U-Frame Power Supply)

2.3.1 Power Controller board

The system uses a distributed power bus. The Power Controller board contains:

- a DC/DC converter that converts the input from the universal power supply to the 12.5 VDC system bus voltage.

The Power Controller contains supervisory circuitry that performs:

- battery charge control (battery switch circuits provide a minimum of 30 minutes of system power in the event of AC power failure);
- current, voltage, and temperature monitoring;
- AC sensing;
- fan control.

Two 12-volt batteries, wired in series, provide the back-up power.

The Power Controller communicates with the Display Unit through a RS-422, 9.6 kB channel. It receives the On/Standby signal from the system switch through the Anesthesia Control board.

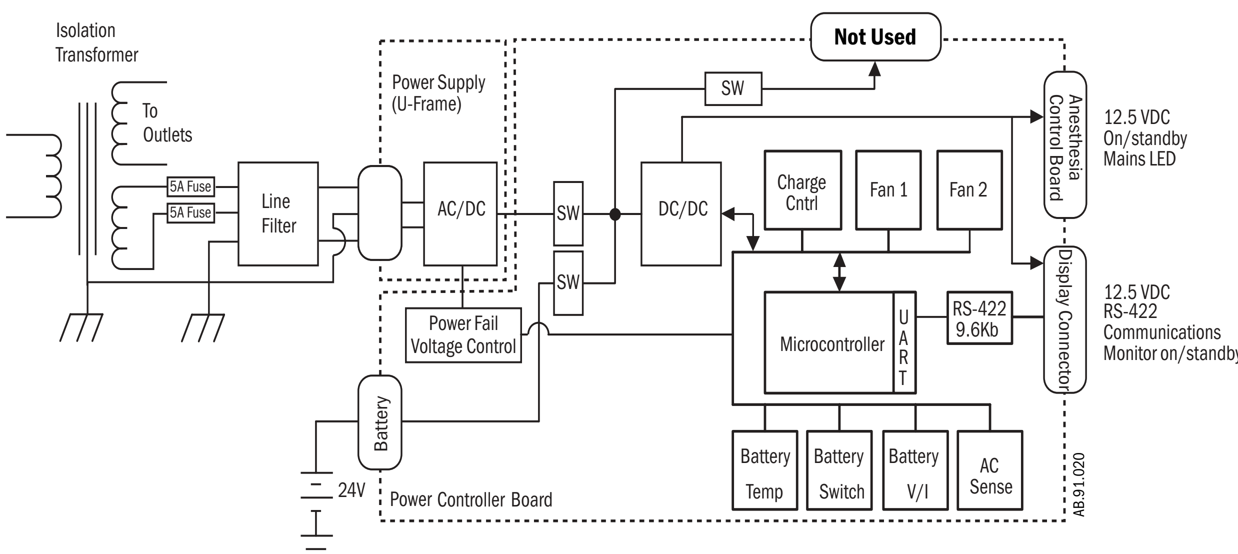


Figure 2-13 • Power subsystem diagram (with U-Frame Power Supply)

2.3.2 Power distribution

The Power Controller board provides outputs to the Anesthesia Control board and the Display Connector board. These boards provide distribution of power supplies required by the system.

The Anesthesia Control board interfaces with the Mixer board and the Ventilator Interface board through the Pan Connector board.

The Display Connector board interfaces with the Display Unit and the Module assembly.

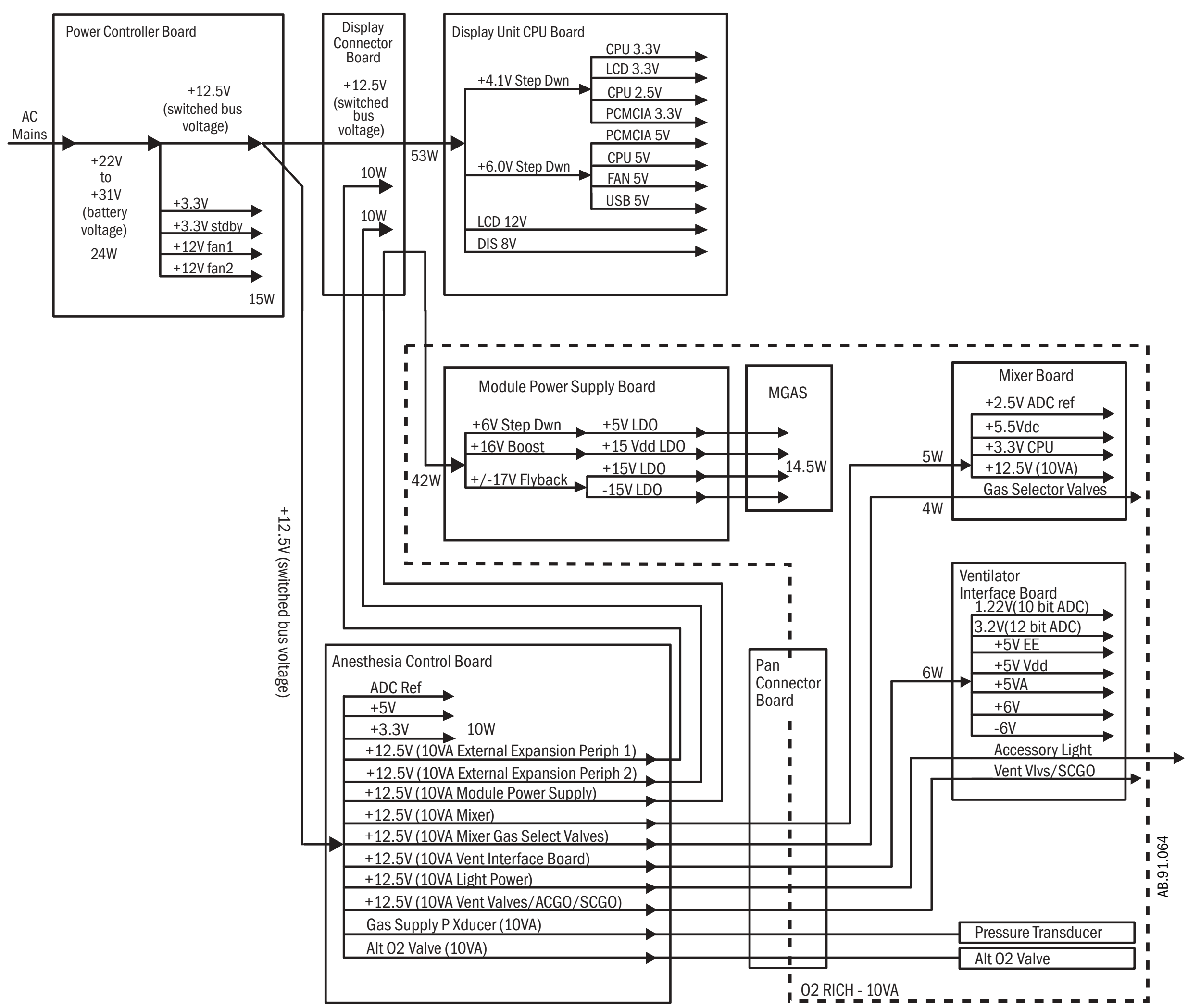


Figure 2-14 • Power distribution (original)

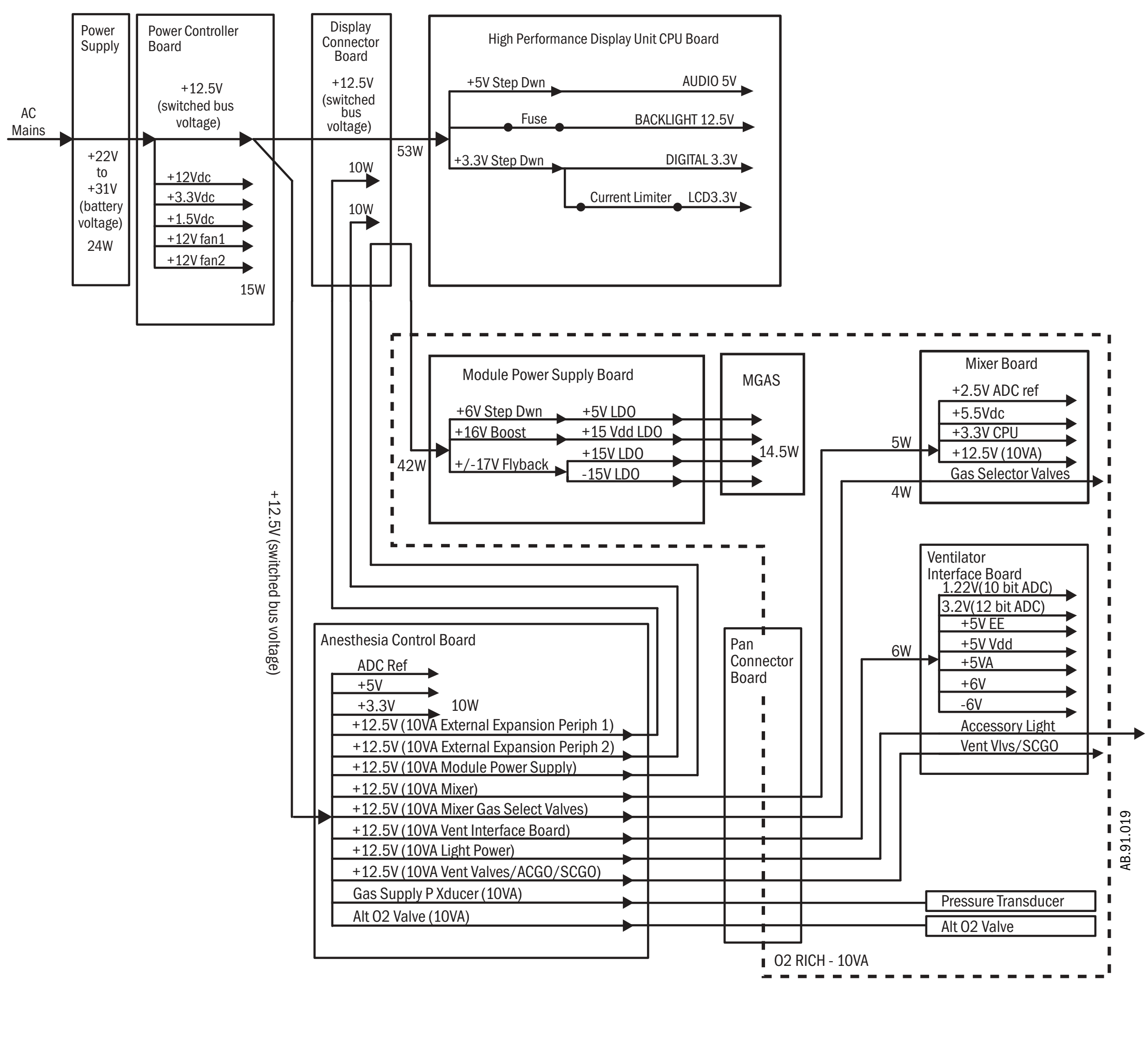


Figure 2-15 • Power distribution (with U-Frame Power Supply and an HPDU)

2.4 System communications

RS-422 serial communication is used between the two main processors — Display Unit and Anesthesia Computer — and the subsystem processors. Various baud rates accommodate data requirements between subsystem and host. External communication uses the standard RS-232 interface.

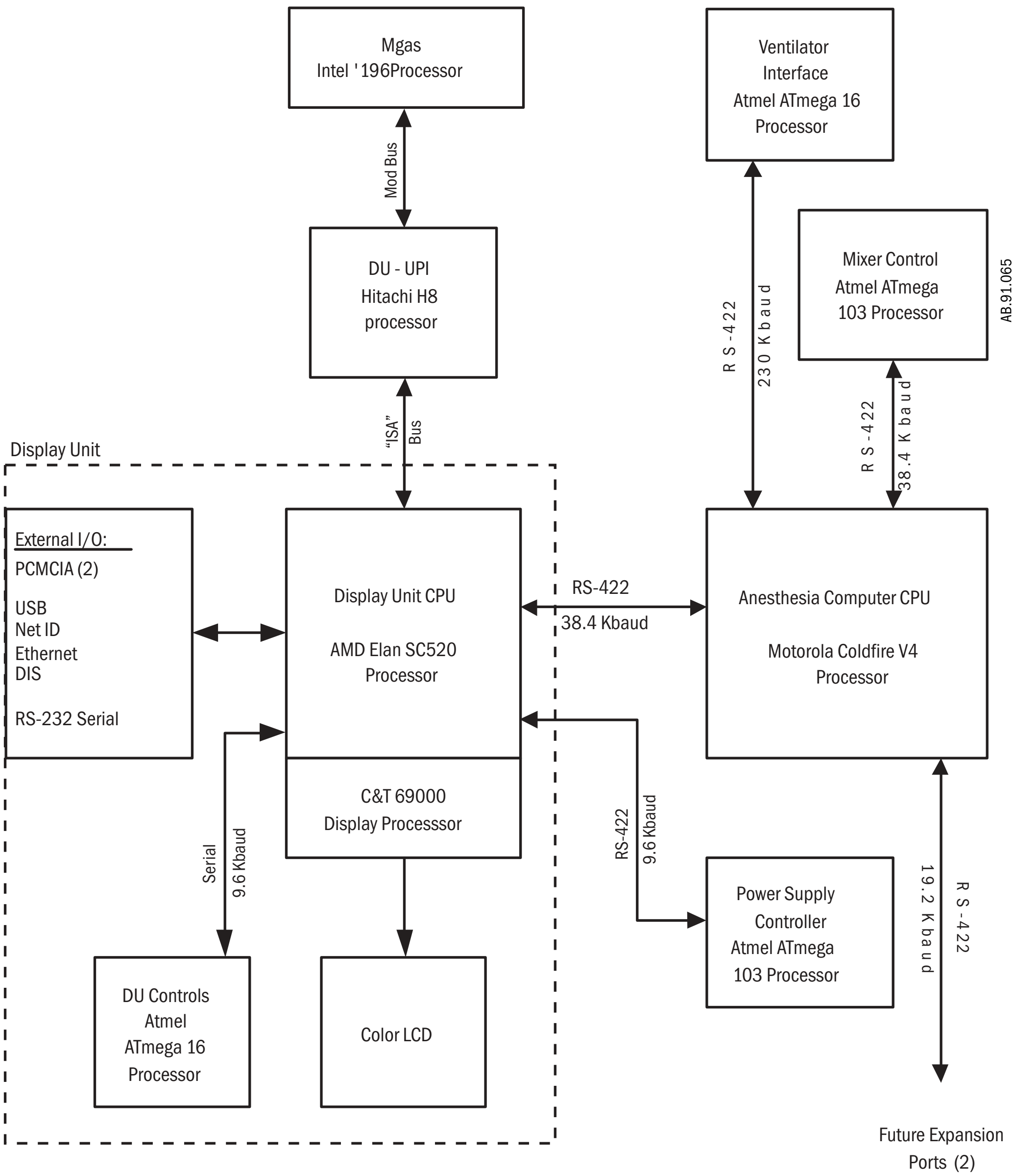


Figure 2-16 • System communications (with DU)

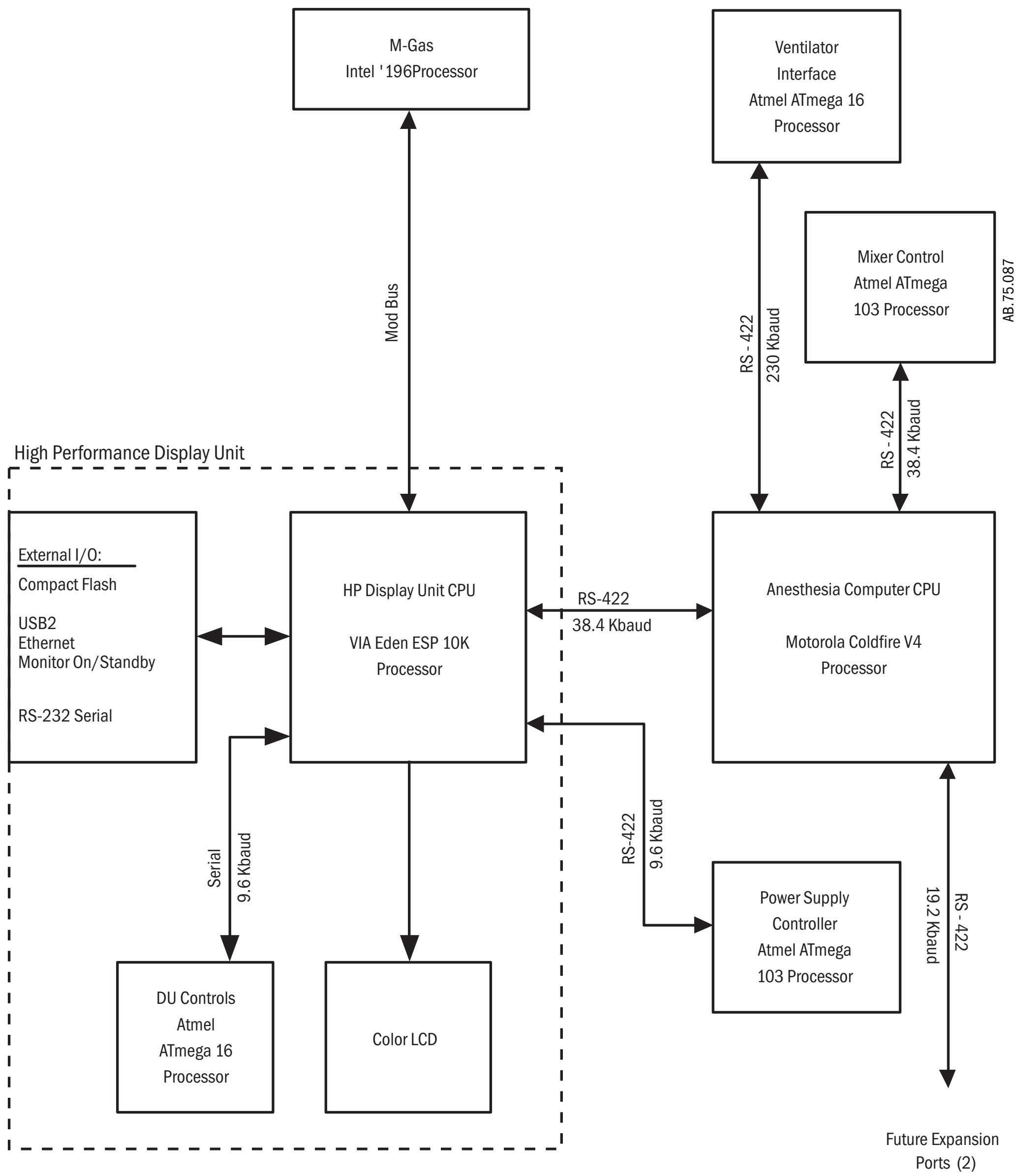


Figure 2-17 • System communications (with HPDU)

2.4.1 Software Power On Self Tests (POST)

When the machine is in the “Off” state (No AC Power connected to the machine and the On/Standby Switch in the “Standby” position, there is no machine activity. Circuitry on the Power Controller Board and on the Anesthesia Control Board monitors the On/Standby Switch for movement.

If the machine state changes from the “Off” state to the “On” state (AC Power connected to the machine while the On/Standby Switch in the “Standby” position), the hospital AC (stepped to approximately 180v AC by the isolation transformer) enters the 150w Power Supply (or PCB). The AC voltage is converted to +12v dc. Standard CPU tests are performed (including but not limited to RAM, ROM, Watchdog, and application CRC) and the PCB application starts. Once the PCB has passed its CPU tests and the application is running, the +12 v circuit to power the DU and the ACB is activated. The DU and ACB simultaneously begin powering on. The PCB evaluates the battery capacity and charges the batteries, if necessary.

Both the ACB and the DU begin by converting the incoming +12 v dc to local needed power (+3.3 v, +4 v, +5 v, +8 v, etc.) and perform standard CPU tests. Each board loads their software (that resides locally) and begins their appropriate self tests described below:

- Once the ACB passes all CPU tests and application is loaded, independent circuitry turns on 10 VA limited (+12 v dc) power to the Gas Mixer, the Ventilator Interface Board, and the M-Gas Power Supply Board. These boards convert the incoming +12 v dc into locally need power supplies and simultaneously begin to power up. The ACB energizes the Alt O2 Selector Valve, which closes the valve. The ACB begins testing the GIV.
    - The processor on the Gas Mixer board performs standard CPU tests, checks communication link with the ACB, reports to the ACB that it has begun to perform Power-On Self Tests (POST). The Gas Mixer tests the O2 and Balance Gas channels for leaks and flow delivery from both channels. Once completed, reports to the ACB that all Self-Tests have been completed and the Gas Mixer compatibility information (serial number, hardware revision, and software revision).
    - The processor on the VIB performs standard CPU tests and begins to download application software and ventilator calibration constants from the ACB. The VIB works in conjunction with the ACB to perform the GIV test (ACB provides valve status information to the VIB, the VIB calculates the voltage necessary to open the valve to the desired value). Once completed, the VIB reports to the ACB Self-Tests have been completed and the VIB compatibility information (serial number, hardware revision, and software revision).
    - There is no processor on the M-Gas Power Supply. Local voltages are produced for the M-Gas and available if a M-Gas is installed. The M-Gas module performs its on POST.

- Once the DU passes all the CPU tests, the DU application is started. Part of this application is software that enables the DU CPU to communicate with the M-Gas module. These applications take longer to start than any other system in the machine. When the applications have completely loaded and communication has been established with the ACB, all the systems compatibility information is transferred to the DU for comparison with the compatibility table created during the last software download. If the compatibility does not match, the machine enters the System Malfunction.

If the On /Standby switch is moved to the “On” position while the machine is in the “Off” state, the circuitry on the Power Controller Board engages the batteries to power the CPU on the PCB. Standard CPU tests are performed and the PCB application starts. Once the PCB has passed its CPU tests and the application is running, it activates the +12 v circuit to power the DU and the ACB. The DU and ACB simultaneously begin powering on. The PCB evaluates the battery capacity.

2.5 Display Unit

The Avance anesthesia machine can use one of two display units:

- the original Display Unit (DU),
- or the High Performance Display Unit (HPDU).

The display unit handles most of the machine's user interface functions through the front panel controls and the LCD screen. It is the primary interface to external peripherals.

The main components of the display unit include:

- An active matrix thin film transistor liquid crystal display (**A**)
- The CPU board (**B**)
- The System Interconnect assembly (**C**)

The CPU board includes a host processor and three coprocessors to handle display, front panel, and monitoring interfaces.

Both the DU and HPDU use a lithium battery to power the real time clock when the machine is in Standby or Off states. The HPDU also uses the lithium battery to retain the BIOS setup. If the battery is removed or becomes disconnected, the BIOS setup needs to be restored by booting the system off the Software Download Card.

2.5.1 Software requirements

The DU uses a PCMCIA interface to handle software upgrades and to load the diagnostics Service Application. The DU is compatible with system software version 3.2 or earlier.

The HPDU uses a Compact Flash interface to handle software upgrades and to load the diagnostics Service Application. The HPDU requires system software version 4.X or greater.

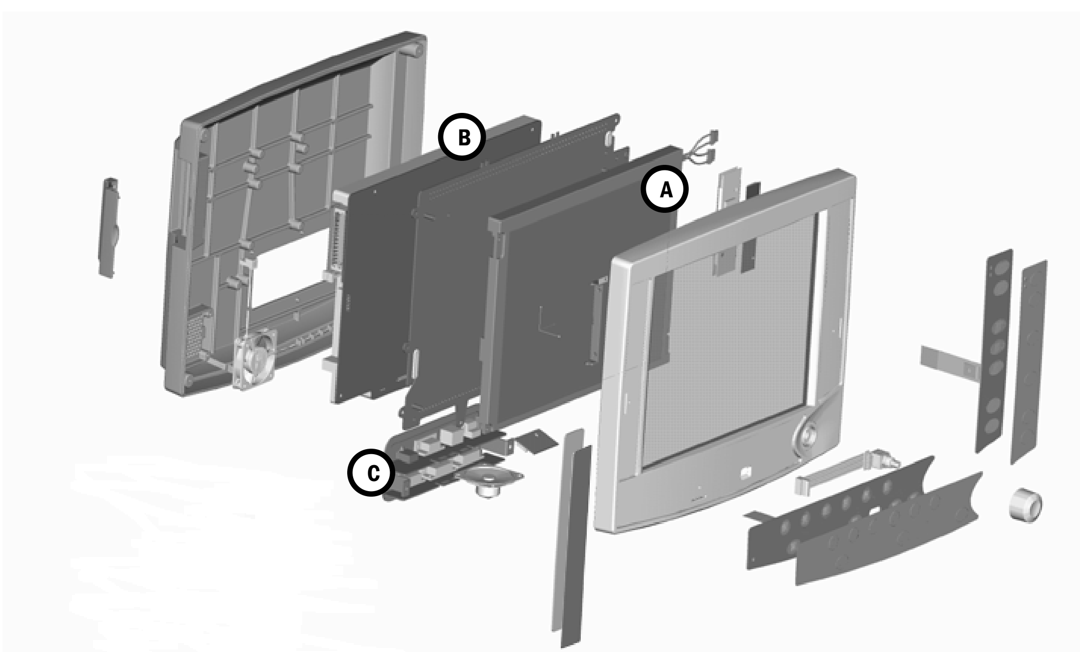


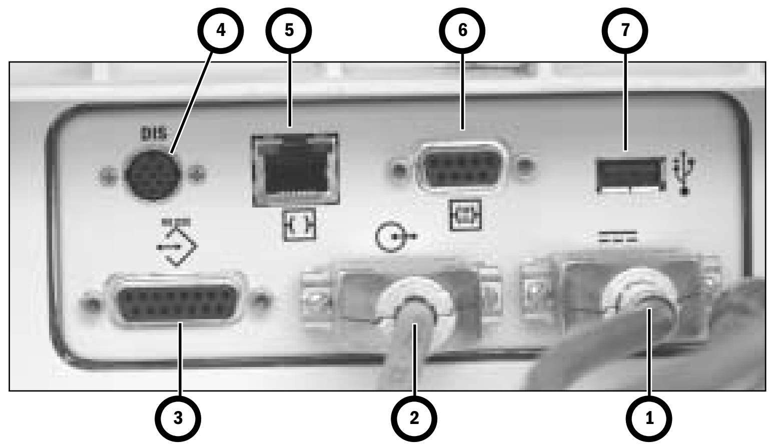
Figure 2-18 • Display Unit

2.6 System connections

2.6.1 Display Unit

The DU accommodates the following connections:

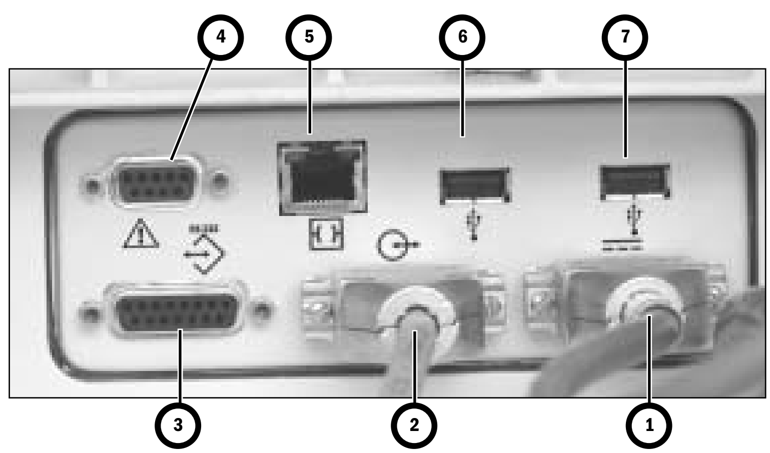
- System Power Interface (**1**).
- System Signal Interface (**2**).
- Serial Port — standard interface for external communication (**3**).
- DIS connector — supports D-O Device Interface Solution (DIS) (**4**).
- Network connection — Standard Ethernet port for network connectivity (**5**).
- Network ID — accept D-O proprietary network identification plug (**6**).
- USB port — standard USB 1.1 interface (**7**).



2.6.2 High Performance Display Unit

The HPDU accommodates the following connections:

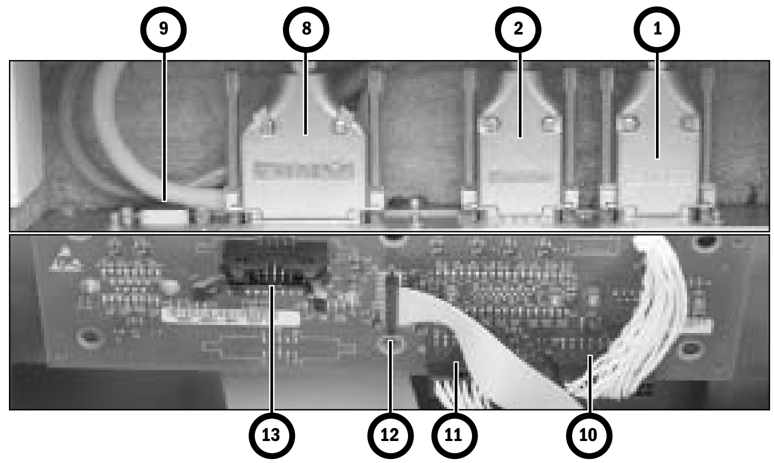
- System Power Interface (**1**).
- System Signal Interface (**2**).
- Serial Port — standard interface for external communication (**3**).
- Remote monitor On/Standby (**4**).
- Network connection — Standard Ethernet port for network connectivity (**5**).
- USB port — standard USB 2.0 interface (**6**).
- USB port — standard USB 2.0 interface (**7**).



2.6.3 Display Connector board

The top side of the Display Connector board accepts the following cables:

- System Power Interface to Display Unit (**1**).
- System Signal Interface to Display Unit (**2**).
- Airway Module (MGAS) Power Supply board (**8**).
- Not used (**9**).
- The under side of the Display Connector board accepts the following cables:
- Power Controller board (**10**).
- Anesthesia Control board (MGAS power) connector (**11**).
- Anesthesia Control board (signal) connector (**12**).
- Not used (**13**).



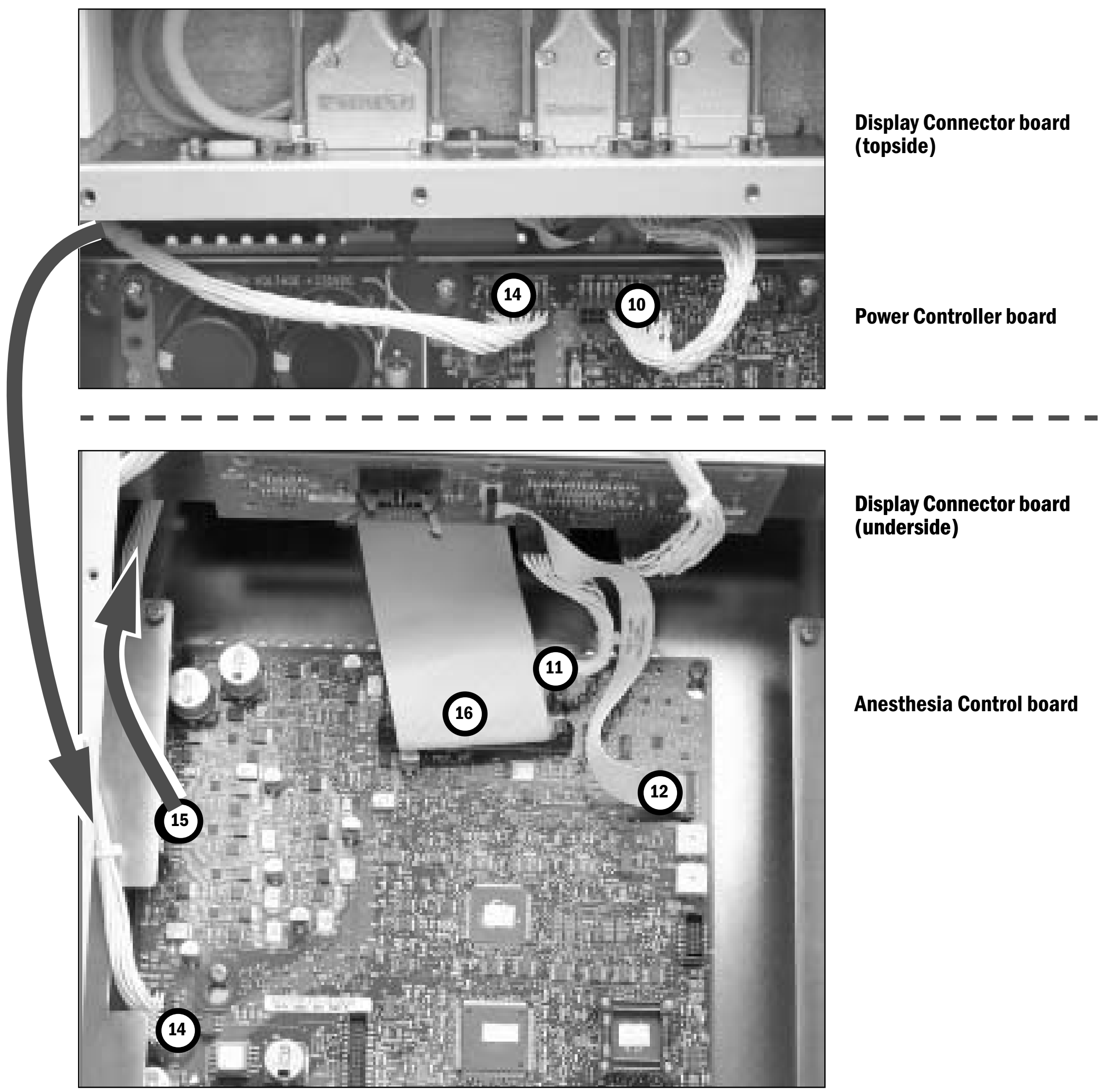
2.7 Power Controller and Anesthesia Control board connections

The Power Controller:

- Distributes 12.5 VDC power and communicates with the Display Unit (by way of the Display Connector board) through connector (**10**).
- Distributes 12.5 VDC power to the Anesthesia Control board through connector (**14**).

The Anesthesia Control board:

- Receives power from the Power Controller board through connector (**14**).
- Distributes 10VA power supplies to the Pan Connector board through connector (**15**).
- Communicates with Pan assemblies through connector (**16**).
- Communicates with Display Unit through connector (**12**).
- Distributes 10VA power supplies to the Display Unit through connector (**11**).



2.8 Anesthesia Control board

The Anesthesia Control board (**A**) uses a Motorola MCF5307 Coldfire microcontroller with 4M Flash and 16M error correcting DRAM. The Anesthesia Control board includes 6 UARTs with a 64 byte FIFO and RS-422 communications to interface with the Display Unit, an accessory port, and anesthesia delivery subsystems located in the pan electronic enclosure. These include the Gas Mixer and the Ventilator Interface board.

Figure 2-19 • Anesthesia Control board

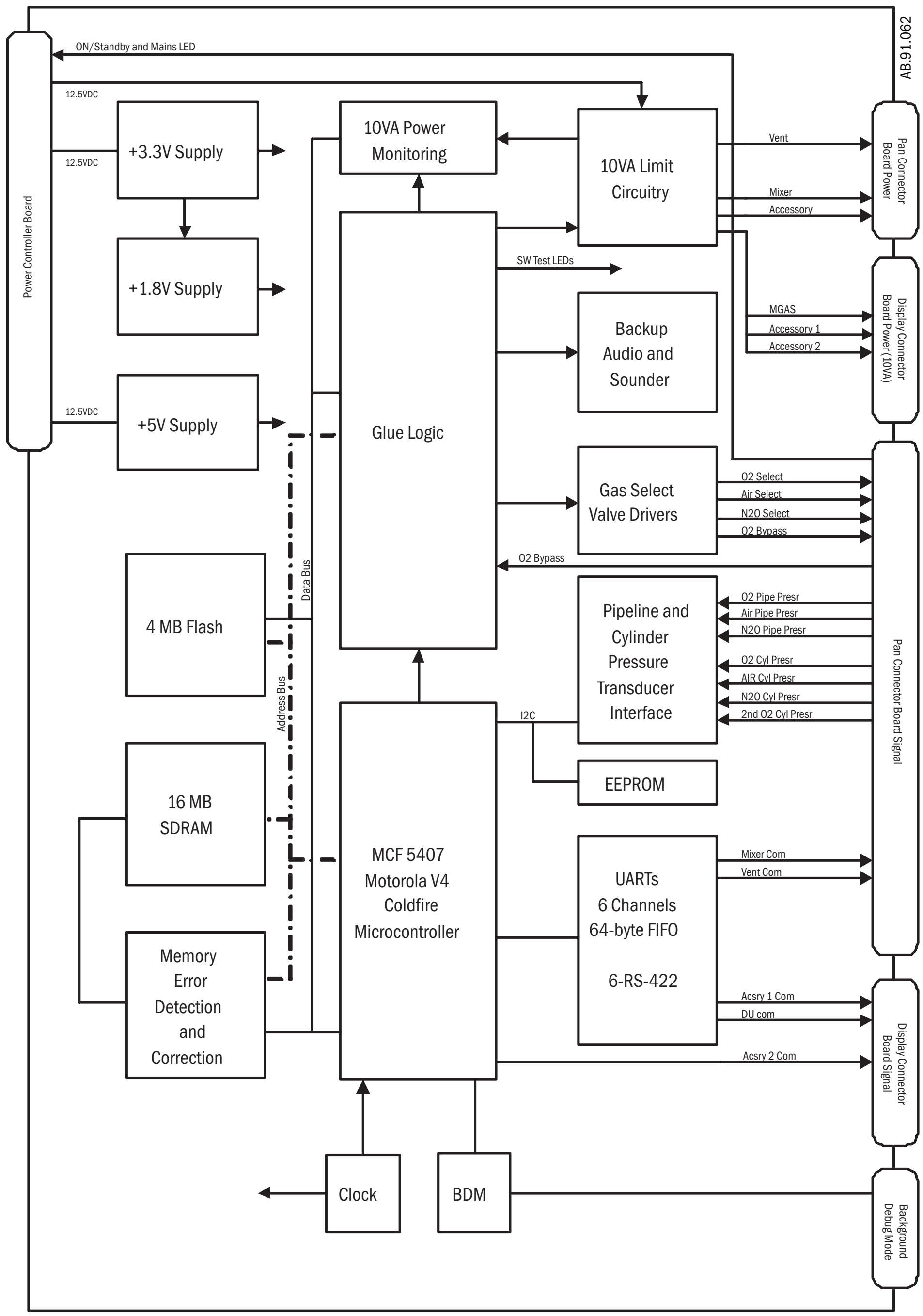


Figure 2-20 • Anesthesia Control board block diagram

2.9 Electronic Gas Mixer

The Gas Mixer receives its pneumatic inputs from the pipeline and cylinder supplies and sends mixed gas to the vaporizer manifold. The Gas Mixer interfaces to the Anesthesia Control board for power and communications.

The Gas Mixer consists of the following subassemblies and main components:

- Gas Mixer board (**A**)
- Control Manifold (**B**) — manifold, selector valves, proportional valves
- Flow sensor assembly (**C**)
- Mixed gas manifold and exit check valve (**D**)

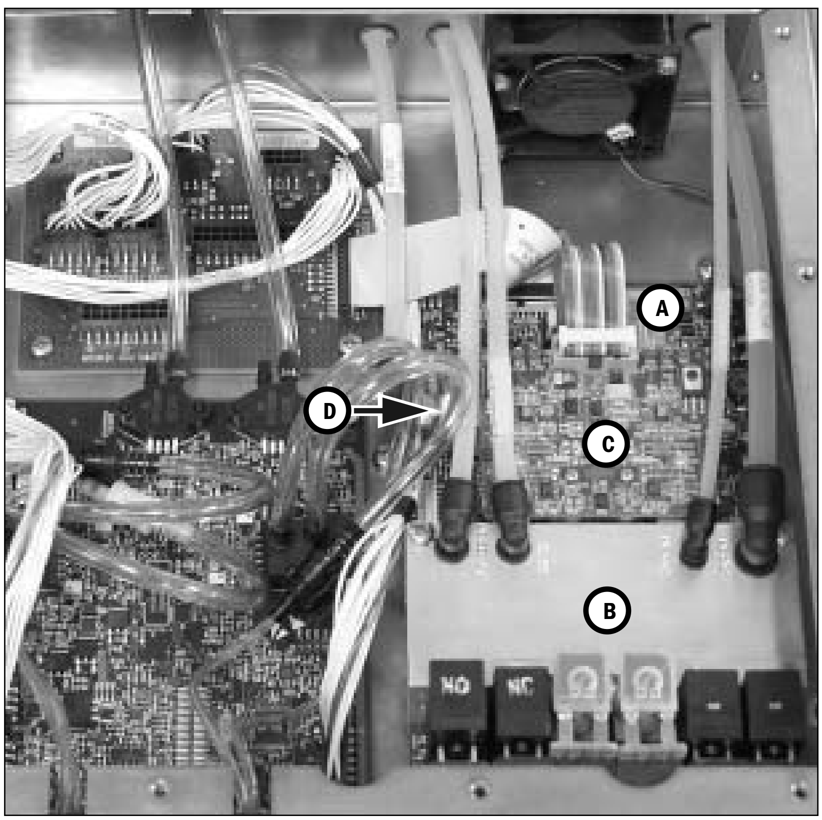


Figure 2-21 • Electronic Gas Mixer

Desired gas flows are sent from the Anesthesia Control board to the Gas Mixer.

Gas Mixer operation is controlled through a microcontroller which:

- Sends requests for the Anesthesia Control board to open and close selector valves for O_2, N_2O and Air.
- Regulates flow control valves for O_2 and balance gas (N_2O or Air).

Closed-loop flow control is accomplished through a hot-wire anemometer in concert with the flow control valves. Gas flow, based on a calibration table, is on target when the reference measurement equals the flow measurement.

Pressure measurements across each of the flow sensor channels are used as checks on the flow measurement for hazard mitigation, ambient pressure compensation, and compensation for back pressure downstream of the Mixer.

In case of certain failures or errors, Alternate O_2 control activates automatically to delivers O_2 (and agent, if turned on) through an alternate pneumatic path to the patient circuit. Alternate O_2 can be activated manually through a front panel control.

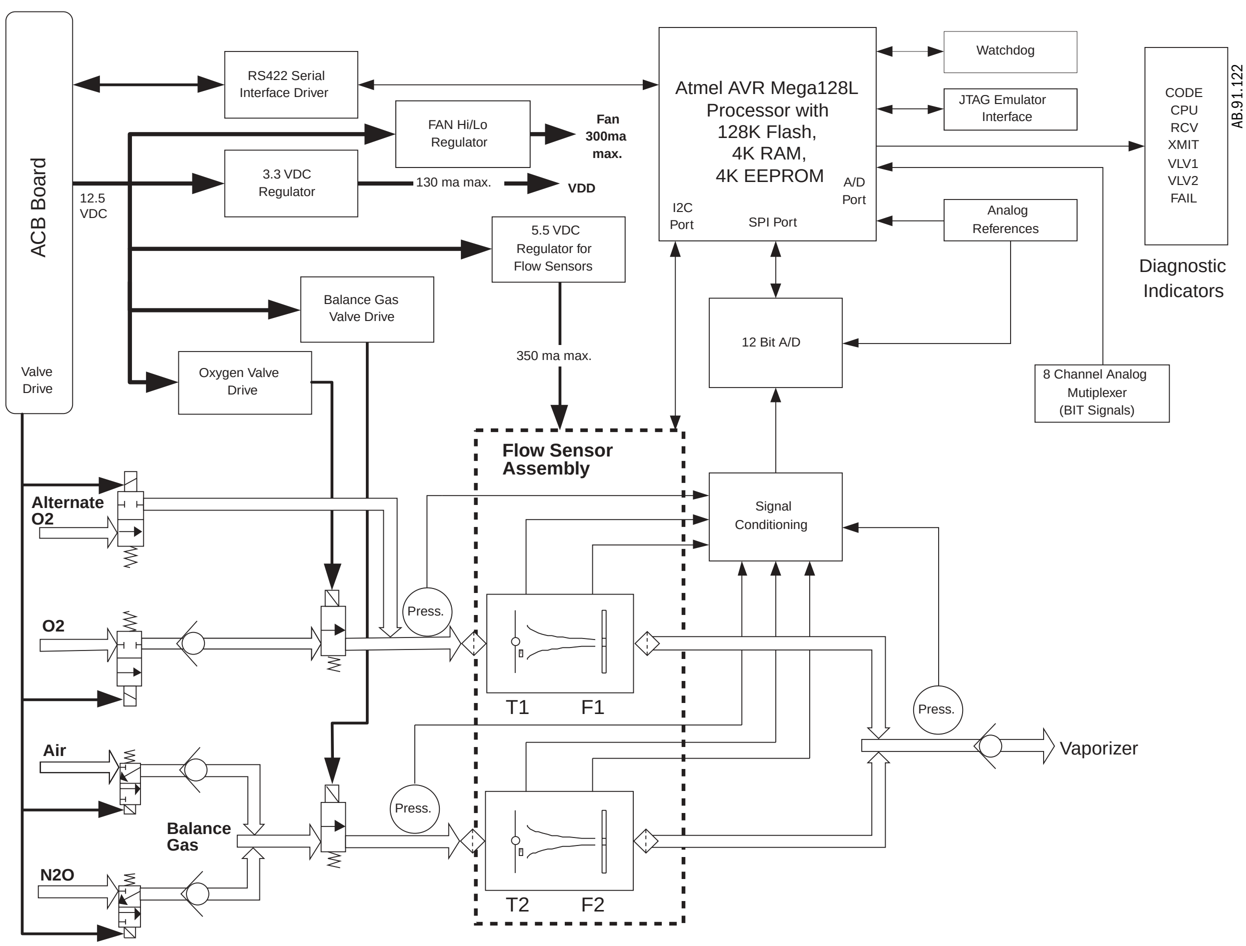


Figure 2-22 • Electronic Gas Mixer block diagram

2.10 Ventilator Interface board

The Ventilator Interface board (**A**) provides the electrical and/or pneumatic interface to the following:

- Inspiratory (**B**) and expiratory (**C**) flow sensors (transducers)
- Patient airway (**D**) and manifold (**E**) pressures (transducers)
- Oxygen sensor (in breathing system)
- ABS On switch
- Canister Release switch
- ACGO position switch (if ACGO installed)
- SCGO solenoid, SCGO/CGO position switches (if SCGO installed)
- Bag/Vent switch
- O_2 Flush switch
- Gas Inlet Valve
- Inspiratory Flow Valve
- Accessory Power (for task lights)

The Ventilator Interface board functions are managed locally by a microcontroller. The microcontroller communicates data values to the controlling CPU via an RS-422 serial interface.

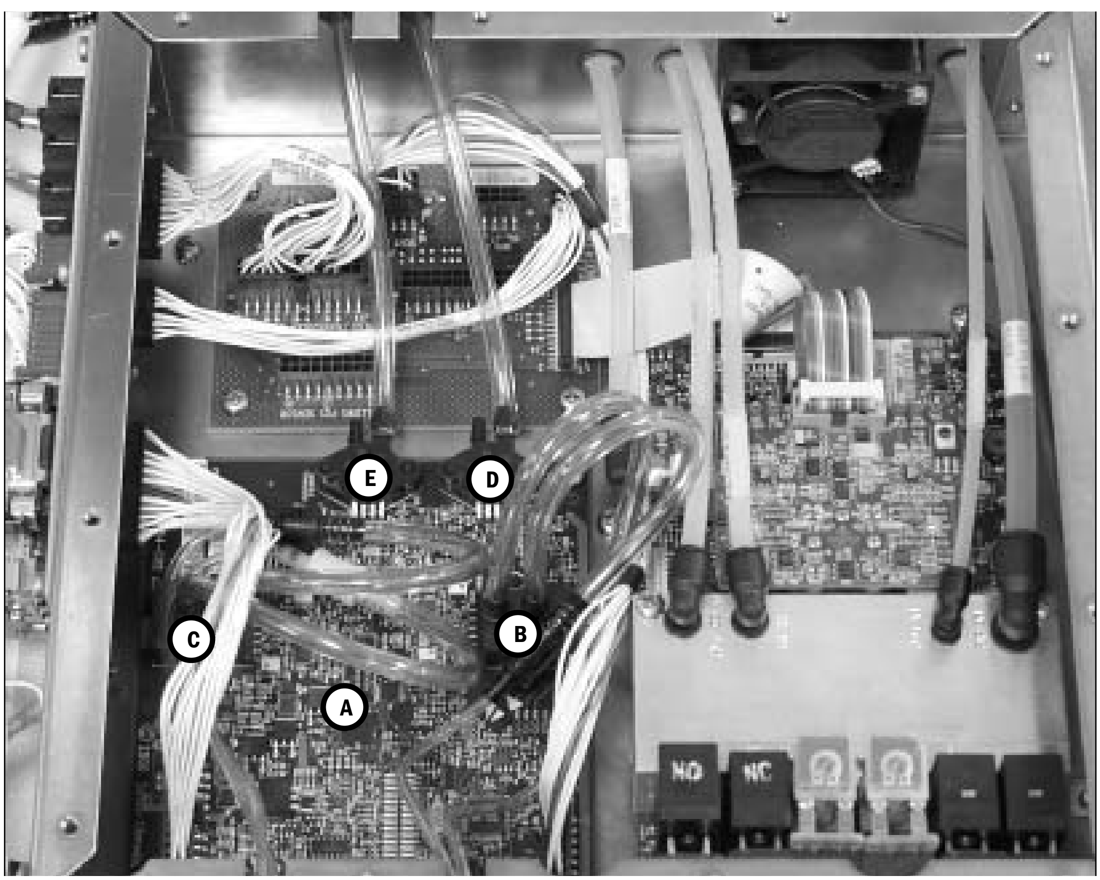


Figure 2-23 • Ventilator Interface board

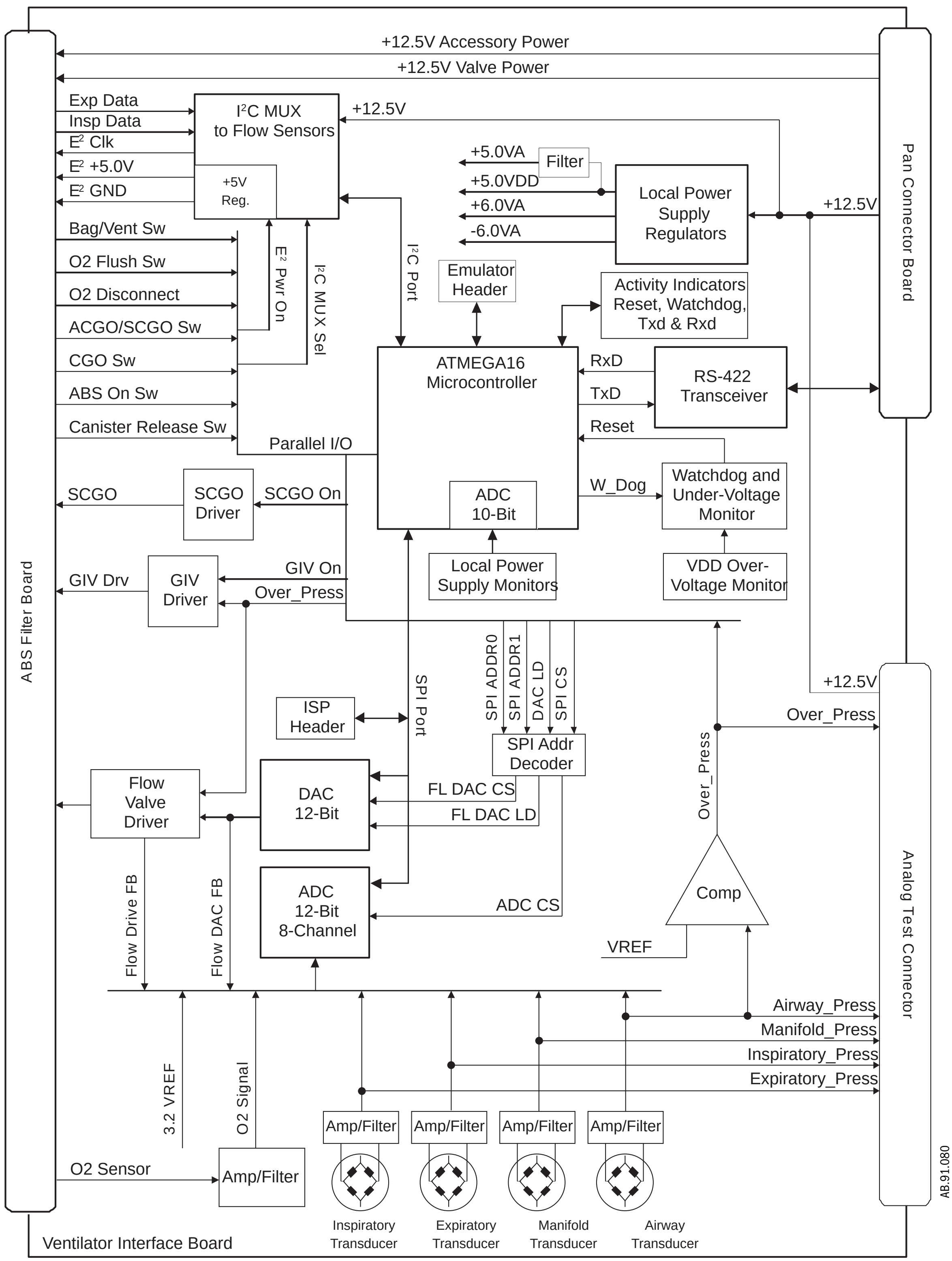


Figure 2-24 • Ventilator Interface board block diagram

2.11 Gas flow through the anesthesia machine

2.11.1 Overview

Refer to Figure 2-25.

Gas supplies

Gas comes into the system through a pipeline (**1**) or cylinder (**6**) connection. All connections have indexed fittings, filters, and check valves (one-way valves). Pressure transducers monitor the pipeline (**2**) and cylinder (**7**) pressures.

The O_2 supply failure alarm is derived from the O_2 pipeline and the O_2 cylinder pressure transducer inputs.

A primary regulator (**8**) decreases the cylinder pressures to approximately pipeline levels. A pressure relief valve (**3**) helps protect the system from high pressures.

To help prevent problems with the gas supplies:

- Install yoke plugs on all empty cylinder connections.
- When a pipeline supply is adequate, keep the cylinder valve closed.

Gas flow

Pipeline or regulated cylinder pressure supplies O_2 or Air directly to the ventilator engine (**4a** or **4b**) and as pilot pressure (**4**) for the SCGO assembly (**E**). Connection points are also available for venturi suction (**5a** or **5b**) drive gas supply. An additional O_2 regulator (**18**) decreases the pressure for the O_2 Flush valve (**19**) and the auxiliary O_2 flowmeter (**24**).

The O_2 Flush valve supplies high flows of O_2 to the fresh gas outlet (**22** or **23**) through the SCGO/ACGO assembly (**E/F**). The flush pressure switch (**20**) monitors activation of the flush valve.

Gas mixing

Under normal conditions, with the system switch (**10**) in the On position, the Alternate O_2 Disable valve (**13**) is energized to block alternate O2 flow. Normal gas flows are enabled through their respective selector valves (**11**). The system controls gas flow through the flow control valves (**12**) and derives the individual flow rates through the hot-wire anemometers (**14**).

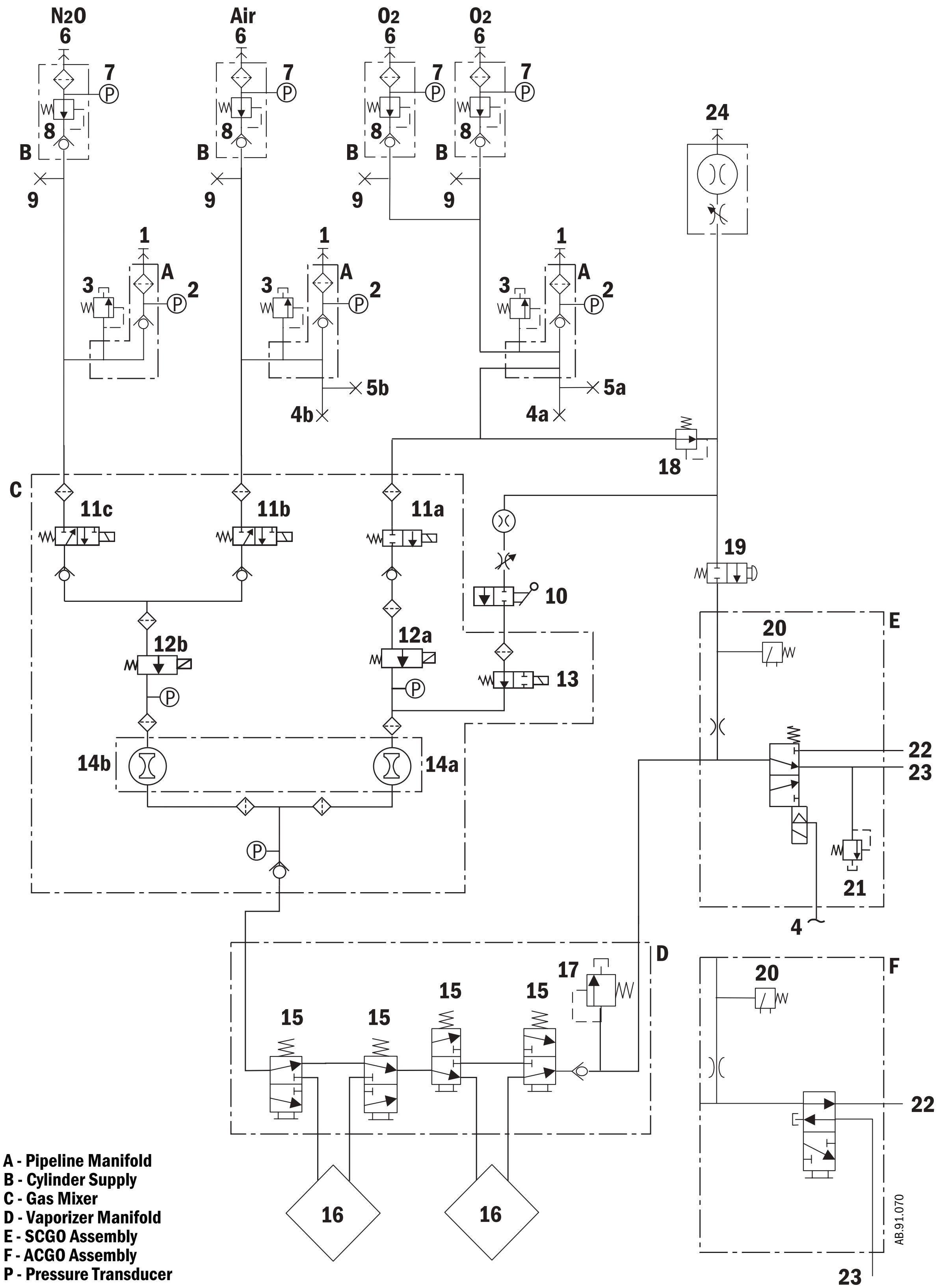
Under system failure conditions (or if Alt O_2 is selected), the normally-open Alternate O_2 Disable valve (**13**) allows delivery of O_2 through the Alternate O_2 Flowmeter when the system switch is in the On position.

Mixed gas

The mixed gas flows through the vaporizer manifold (**D**), and vaporizer (**16**) that is On, to the SCGO/ACGO assembly (**E/F**). A pressure relief valve (**17**) on the vaporizer manifold limits the maximum outlet pressure.

The SCGO assembly (**E**) directs the mixed gas to the selected circuit:
22 (ABS-circle) or **23** (to Inspiratory port of ABS). On SCGO assemblies, a relief valve (**21**) limits pressure in the breathing system to approximately 150 cmH_2O.

The ACGO assembly (**F**) directs the mixed gas to the selected circuit:
22 (ABS-circle) or **23** (external ACGO port).



A - Pipeline Manifold
B - Cylinder Supply
C - Gas Mixer
D - Vaporizer Manifold
E - SCGO Assembly
F - ACGO Assembly
P - Pressure Transducer

Figure 2-25 • Pneumatic circuit

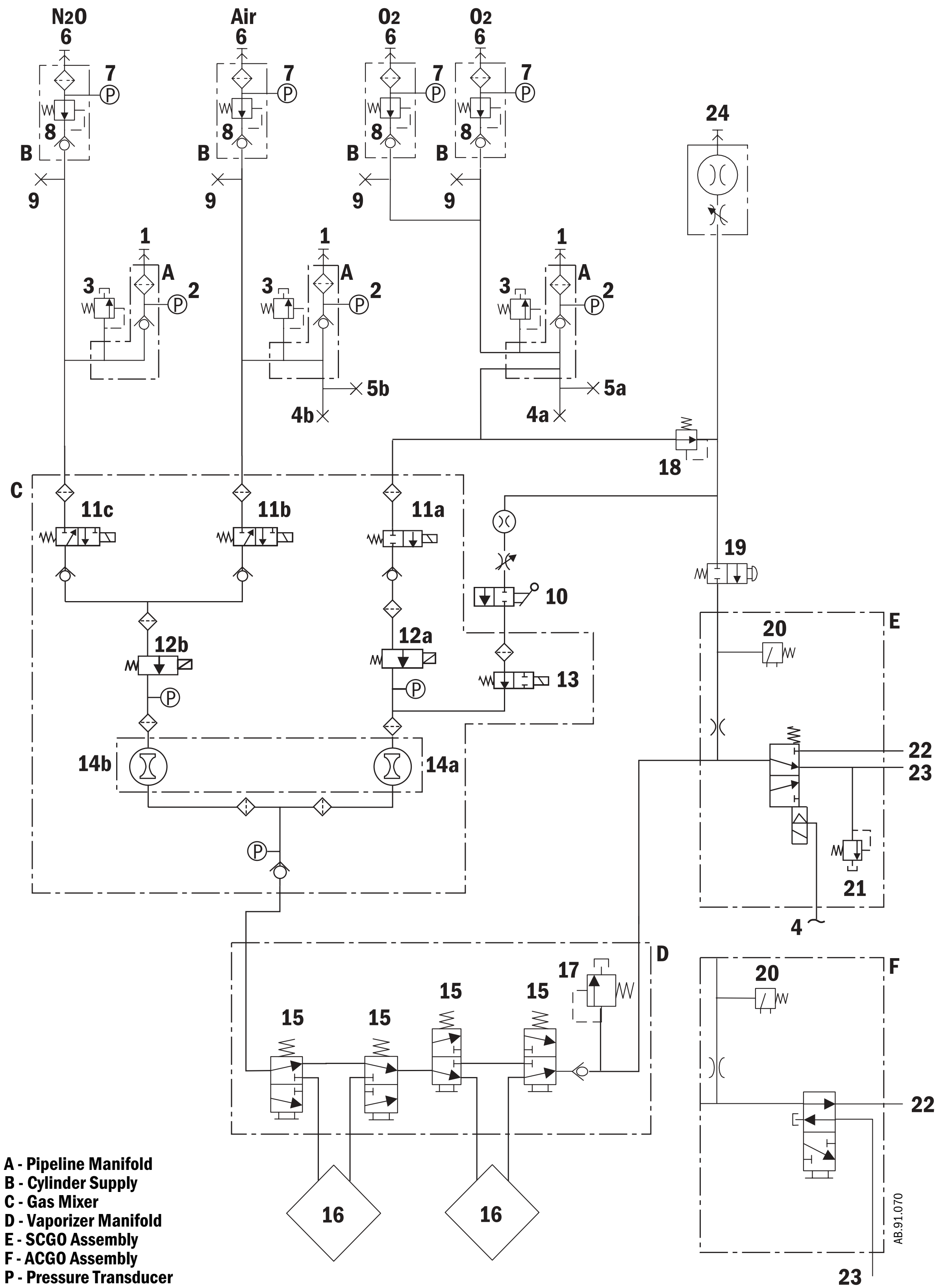


Figure 2-26 • Pneumatic circuit

Refer to Figure 2-26.

Key to Numbered Components

1. Pipeline inlet
2. Pipeline pressure transducer
3. High-pressure relief valve (758 kPa / 110 psi)*
4. Supply connections for the ventilator and pilot pressure for SCGO
   a. O_2 drive gas
   b. Air drive gas
5. Venturi suction supply connection
   a. O_2 drive gas
   b. Air drive gas
6. Cylinder inlet
7. Cylinder pressure transducer
8. Primary regulator (cylinder pressure)
9. Test port (primary regulator)
10. System switch
11. Selector valve
    a = O_2; b = Air; c = N_2O
12. Flow controller
    a = O_2; b = balance gas
13. Alternate O_2 disable valve
14. Hot-wire anemometer
    a = O_2 flow sensor channel; b = balance gas flow sensor channel
15. Vaporizer port valve
16. Vaporizer
17. Low-pressure relief valve (38 kPa / 5.5 psi)*
18. O_2 flush and auxiliary flowmeter regulator (241 kPa / 35 psi)*
19. O_2 Flush valve
20. Pressure switch (used with the ventilator)
21. Breathing system pressure relief valve (SCGO only — 150 cmH_2O)*
22. To Port 3 of ABS interface (circle)
23. For SCGO, to Port 2 of ABS interface (non-circle Inspiratory port)
    For ACGO, to external 22-mm ACGO connector
24. Auxiliary O_2 flowmeter (optional)

* Approximate values

Key to Symbols

Pneumatic Connection

Filter

Direction of Flow

Check Valve

2.11.2 Physical connections

Figure 2-27 shows the physical path that the gas takes. The item numbers are described on the previous page.

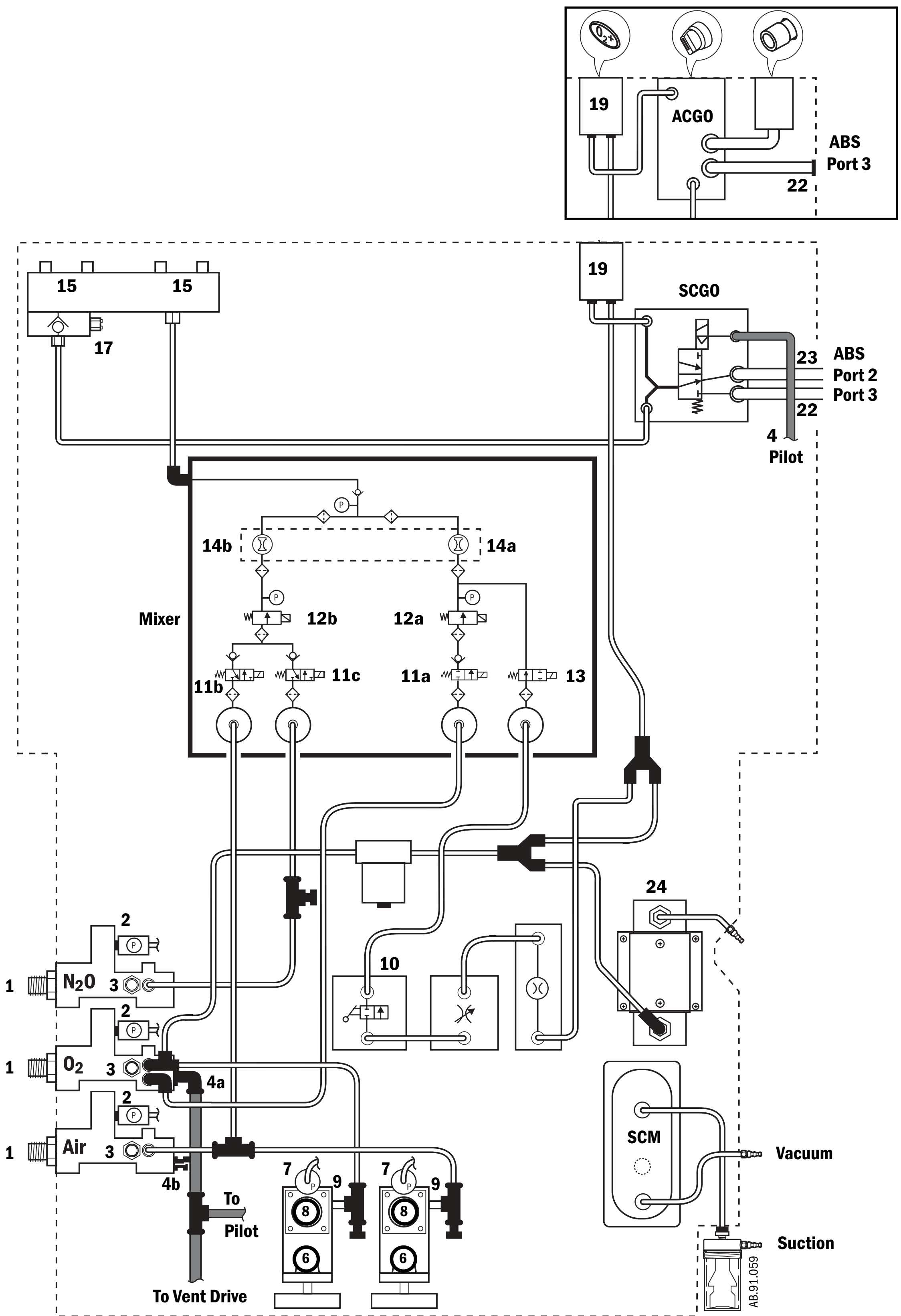


Figure 2-27 • Typical tubing connections - pictorial

2.11.3 Suction regulators

Pipeline vacuum

The suction regulator (shown in Figure 2-27) uses an external vacuum source.

Venturi Drive vacuum

The suction regulator (shown in Figure 2-28) uses an internal, venturi derived vacuum source.

Drive gas (internally plumbed **Air** or **O_2**) enters the Venturi Module (**VM**) at the drive port (**A**). As the drive gas passes through the venturi module, a vacuum is created at port **B**. The drive gas exits the venturi module at port **C** and is exhausted outside the machine through the muffler (**D**).

The control port (**E**) on the venturi module responds to pneumatic signals from the front panel switch on the Suction Control Module (**SCM**) to turn the venturi vacuum drive gas on or off. The check valve (**CV**) helps prevent pressurization of the suction circuitry if the exhaust is occluded or the venturi unit fails.

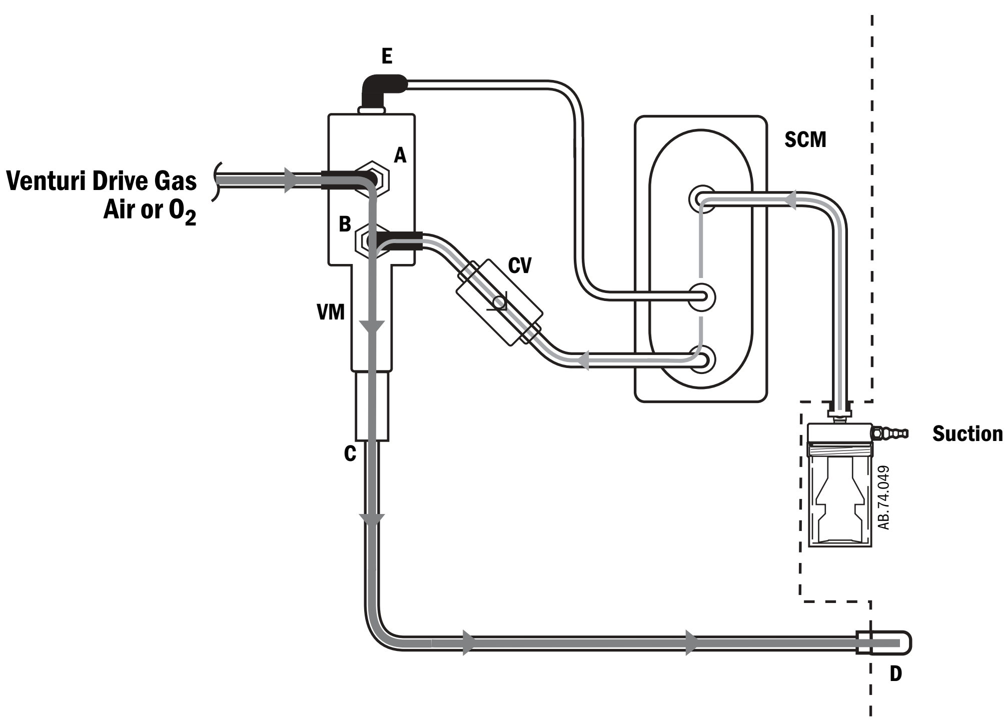


Figure 2-28 • Venturi suction

2.12 Flow through the breathing system

2.12.1 Overview of flow paths

This section looks at four types of flow paths.

- **Ventilation paths:** How gas flows from the drive source (bag or bellows) to and from the patient.
- **Fresh gas paths:** Fresh gas can flow from the machine interface directly to the patient through the inspiratory check valve, or through the absorber into the expiratory flow, or directly to an external circuit through the optional auxiliary common gas outlet.
- **Scavenged gas paths:** APL or Pop-off.
- **Flow through the optional EZchange Canister and Condenser:** EZchange ON and EZchange OFF (CO_2 bypass).

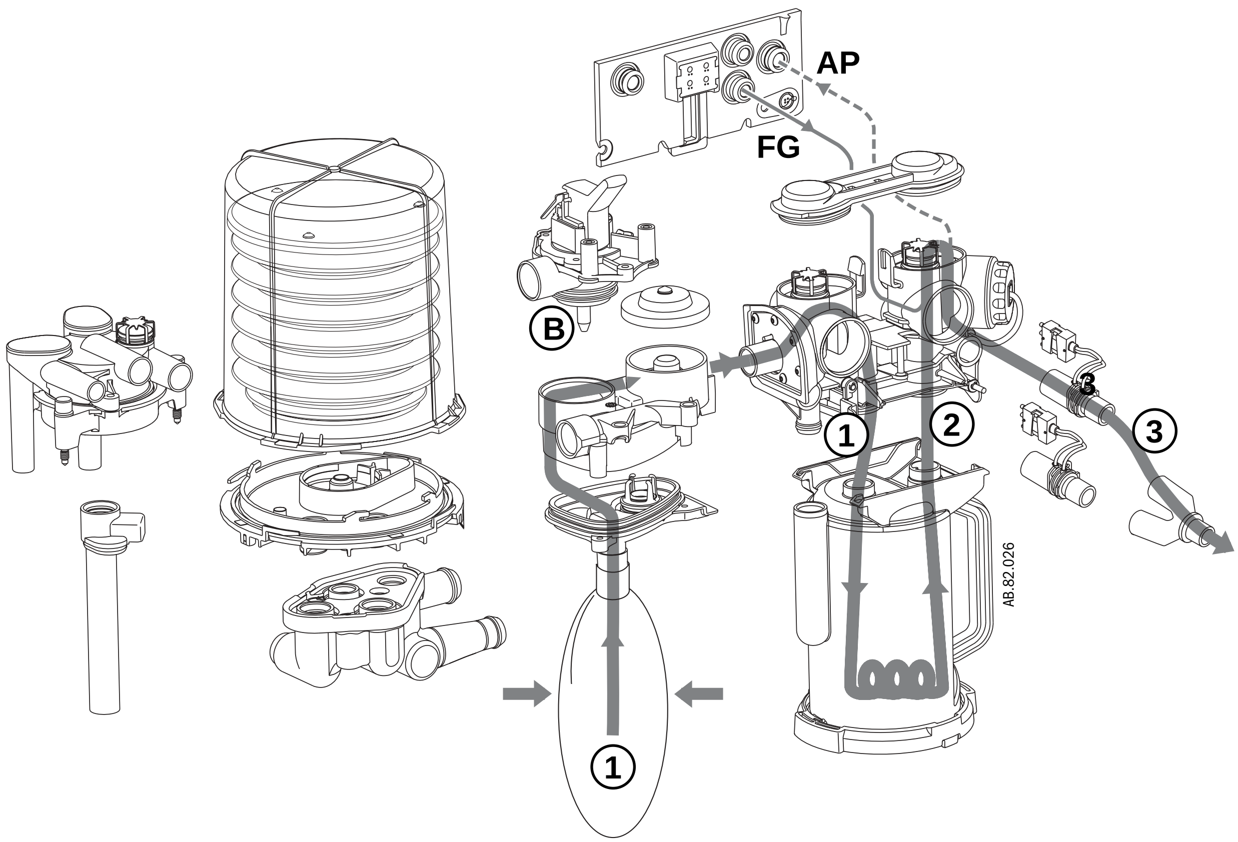
2.12.2 Manual ventilation

Manual inspiration

The Bag/Vent switch closes the ventilator path (**B**).

Gas flows from the bag (**1**), through the absorber (**2**), into the breathing circuit module, and through a unidirectional valve (inspiratory check valve) to the patient (**3**).

During inspiration, fresh gas (**FG**) flows from the machine into the inspiratory limb, upstream of the inspiratory check valve.



AP	Airway Pressure
B	Bag/Vent switch to Bag
FG	Fresh Gas
1	Flow to absorber
2	Flow from absorber
3	Inspiratory flow

Figure 2-29 • Gas flow during manual inspiration

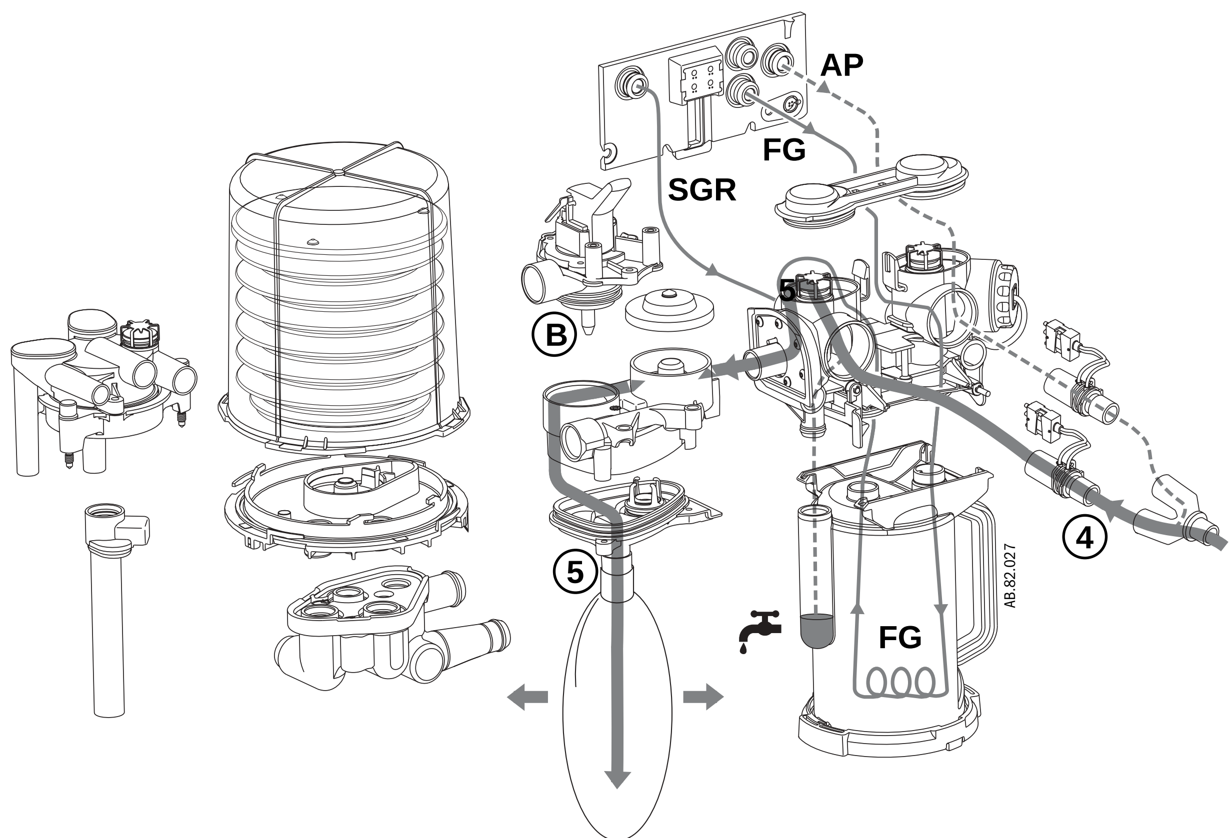
Manual expiration

The Bag/Vent switch keeps the ventilator path closed (**B**).

Gas flows from the patient (**4**), through a unidirectional valve (expiratory check valve), and into the bag (**5**).

During exhalation, fresh gas flows backwards through the absorber (**FG**) into the expiratory limb, downstream of the expiratory check valve.

For machines that are plumbed to return sample gas to the breathing system, the returned gas (**SGR**) enters the breathing system after the expiratory check valve.



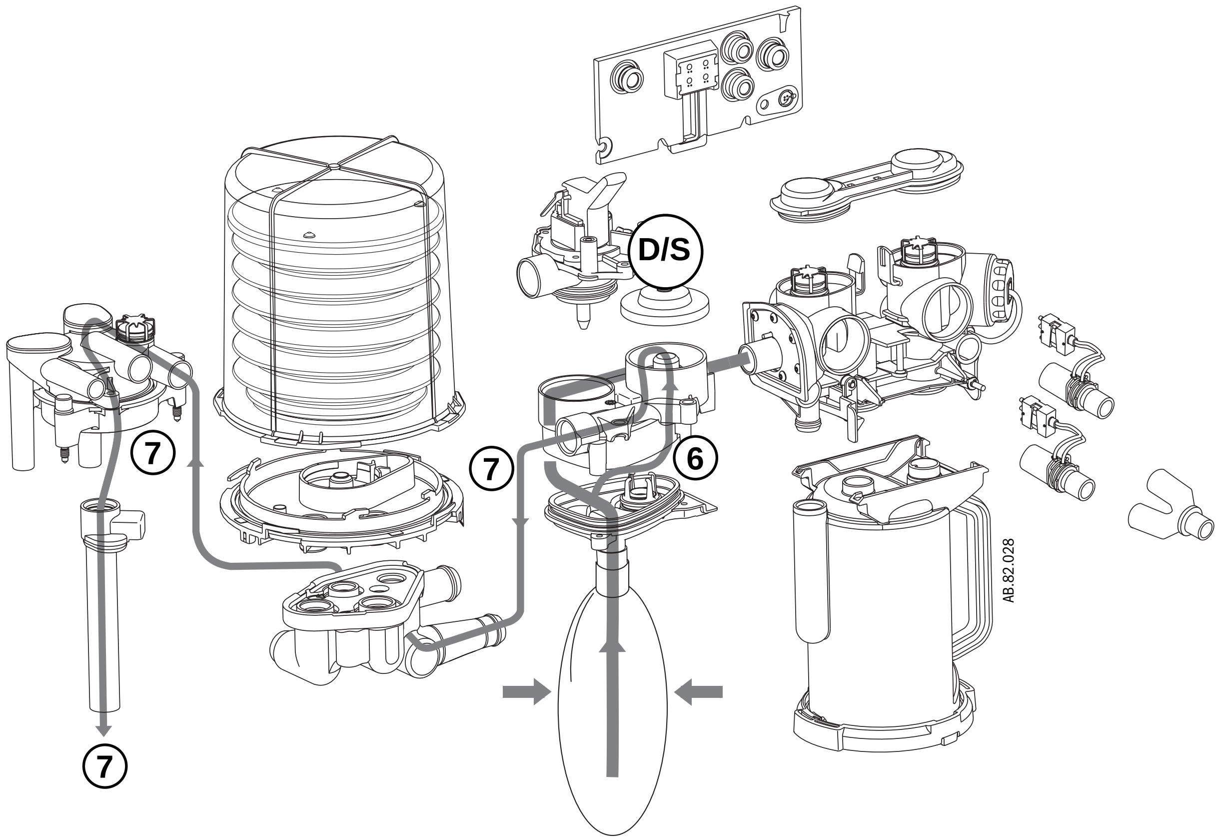
AP	Airway Pressure
B	Bag/Vent switch to Bag
FG	Fresh Gas
SGR	Sample Gas Return
4	Expiratory flow
5	Flow to bag

Figure 2-30 • Flow during manual expiration

APL Valve

The APL valve sets a pressure limit for manual ventilation.

As you turn the APL knob, it puts more or less force on the APL disc and seat (**D/S**). If the circuit pressure is too high (**6**), the disc and seat inside the diaphragm opens and vents gas to the scavenging system (**7**).



D/S	APL disc and seat
6	APL flow
7	To scavenging

Figure 2-31 • Flow through the APL Valve

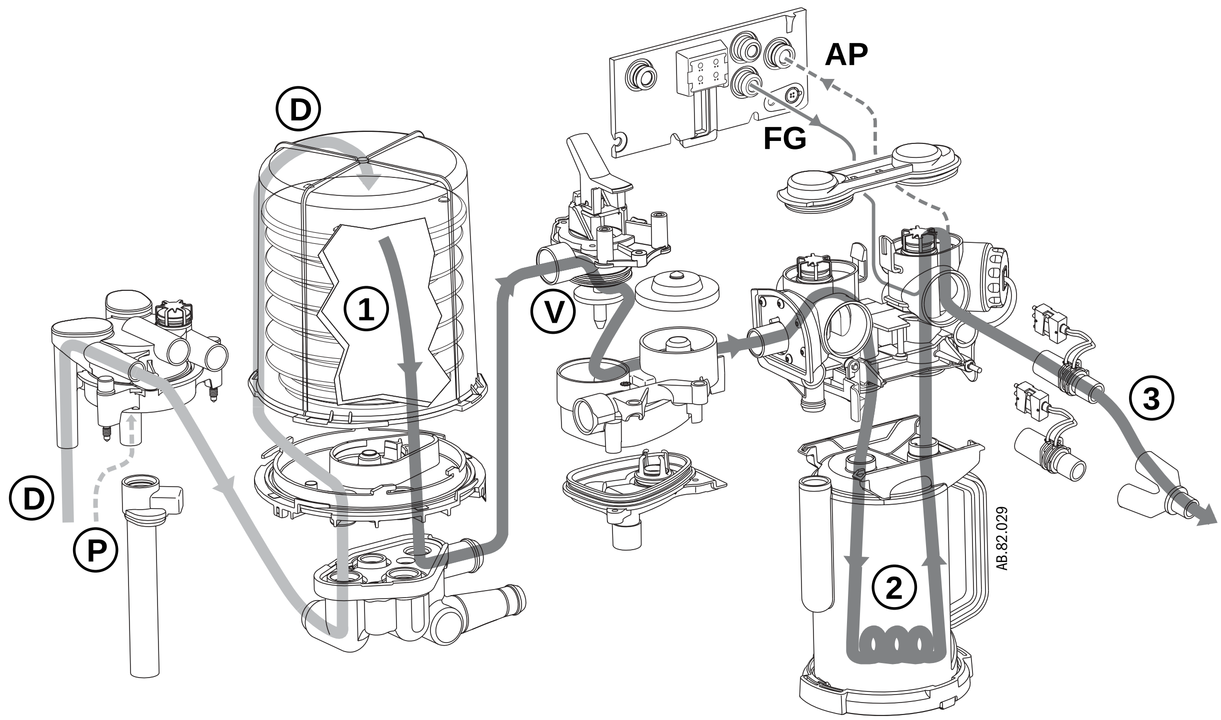
2.12.3 Mechanical ventilation

Mechanical inspiration

The Bag/Vent switch closes the manual path (**V**). Pilot pressure (**P**) closes the exhalation valve.

Drive gas (**D**) pushes down on the bellows. Gas flows from the bellows (**1**), through the absorber (**2**), and through a unidirectional valve (inspiratory check valve) to the patient (**3**).

During inspiration, fresh gas flows into the inspiratory limb, upstream of the inspiratory check valve.



AP	Airway Pressure
D	Drive gas
FG	Fresh Gas
P	Pilot pressure
V	Bag/Vent switch to Vent
1	Flow to absorber
2	Flow from absorber
3	Inspiratory flow

Figure 2-32 • Mechanical inspiration

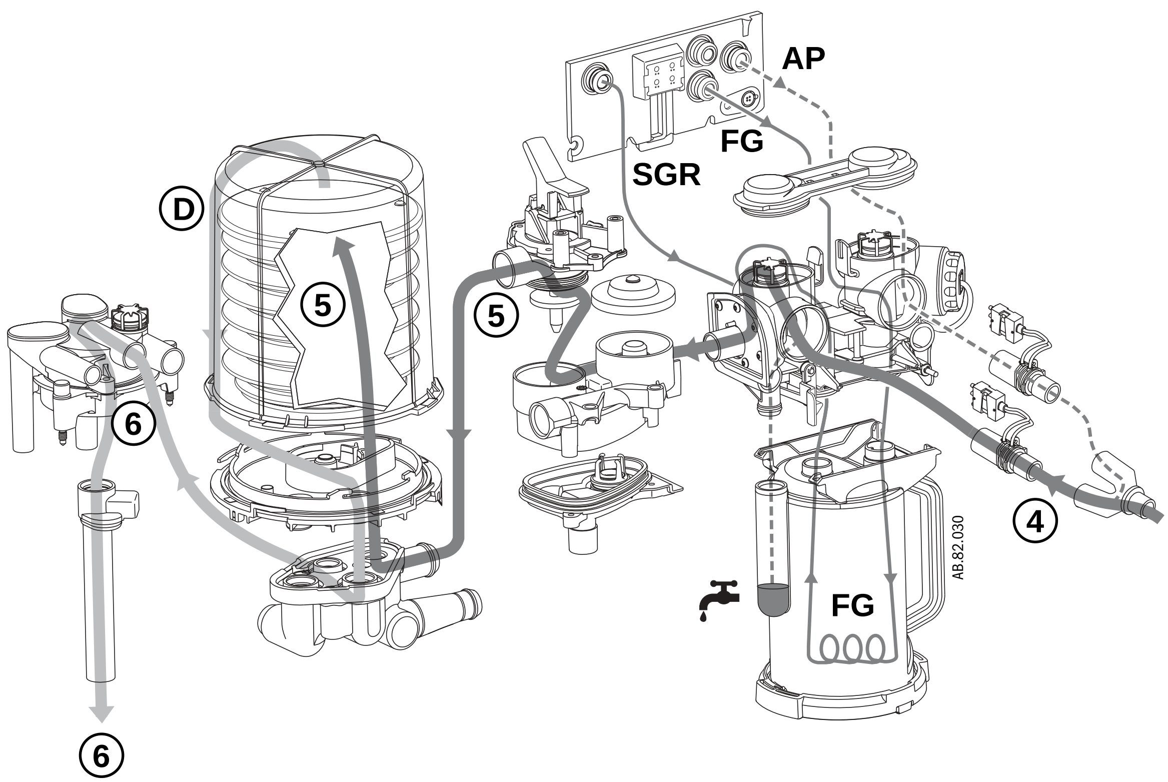
Mechanical expiration

Drive-gas flow stops and the exhalation valve opens. Exhaled gas flows from the patient (**4**), through a unidirectional valve (expiratory check valve) and into the bellows (**5**). Residual drive gas (**D**) flows out of the bellows to the scavenging system (**6**).

If PEEP is selected, static pressure on the pilot port of the exhalation valve sets the PEEP level.

During exhalation, fresh gas flows backwards through the absorber (**FG**) into the expiratory limb, downstream of the expiratory check valve.

For machines that are plumbed to return sample gas to the breathing system, the returned gas (**SGR**) enters the breathing system after the expiratory check valve.



AP	Airway Pressure
D	Drive gas
FG	Fresh Gas
SGR	Sample Gas Return
4	Expiratory flow
5	Flow to bellows
6	To scavenging

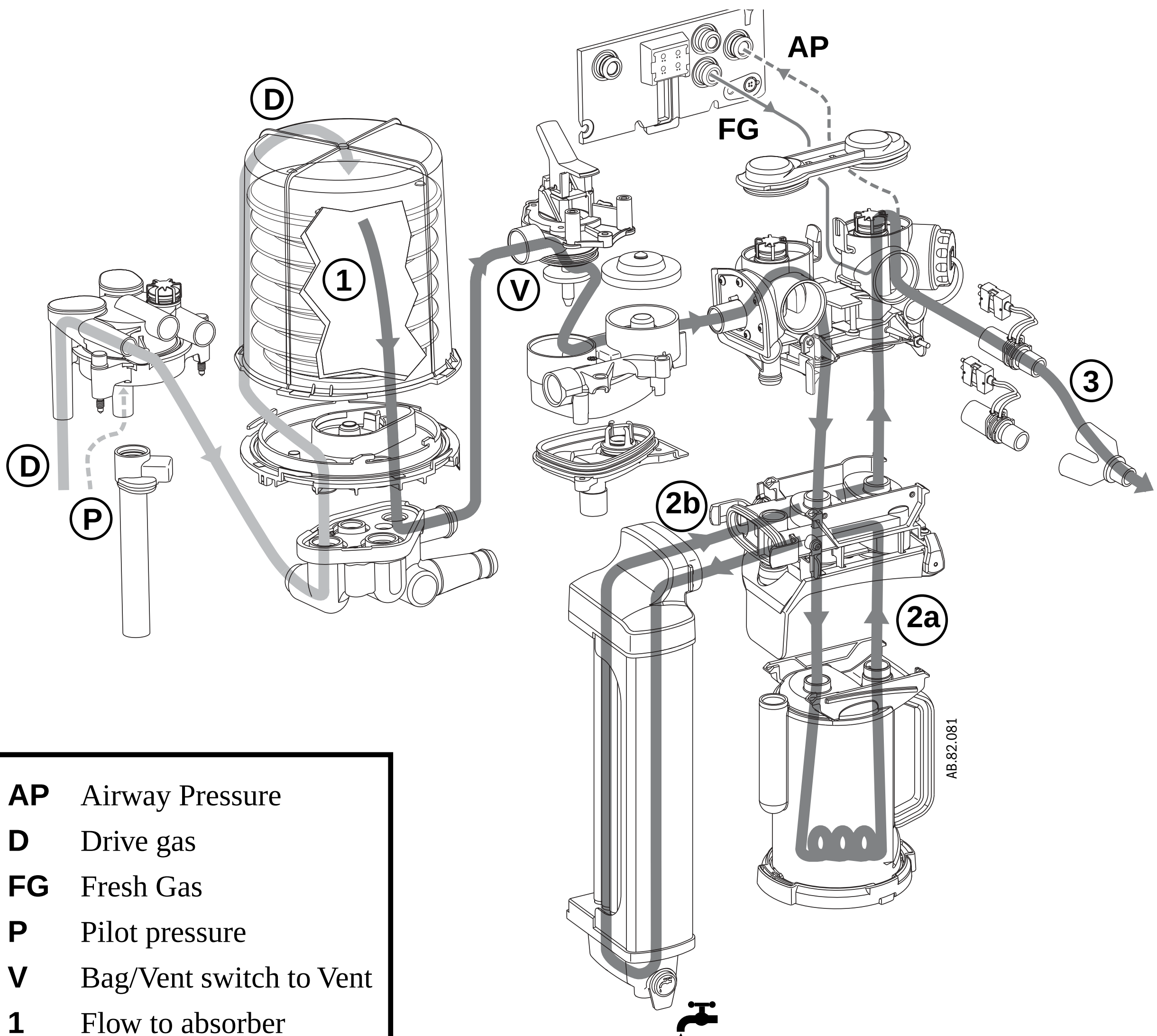
Figure 2-33 • Mechanical expiration

Mechanical inspiration (EZchange and condenser ON)

The Bag/Vent switch closes the manual path (**V**). Pilot pressure (**P**) closes the exhalation valve.

Drive gas (**D**) pushes down on the bellows. Gas flows from the bellows (**1**), through the absorber (**2a**), Condenser (**2b**), and through a unidirectional valve (inspiratory check valve) to the patient (**3**).

During inspiration, fresh gas flows into the inspiratory limb, upstream of the inspiratory check valve.



AP	Airway Pressure
D	Drive gas
FG	Fresh Gas
P	Pilot pressure
V	Bag/Vent switch to Vent
1	Flow to absorber
2a	Flow from absorber
2b	Flow from condenser
3	Inspiratory flow

Figure 2-34 • Mechanical inspiration through Condenser with EZchange Canister and Condenser ON

Mechanical expiration (EZchange and condenser ON)

Drive-gas flow stops and the exhalation valve opens. Exhaled gas flows from the patient (**4**), through a unidirectional valve (expiratory check valve) and into the bellows (**5**). Residual drive gas (**D**) flows out of the bellows to the scavenging system (**6**).

If PEEP is selected, static pressure on the pilot port of the exhalation valve sets the PEEP level.

During exhalation, fresh gas flows backwards through the Condenser and absorber (**FG**) into the expiratory limb, downstream of the expiratory check valve.

For machines that are plumbed to return sample gas to the breathing system, the returned gas (**SGR**) enters the breathing system after the expiratory check valve.

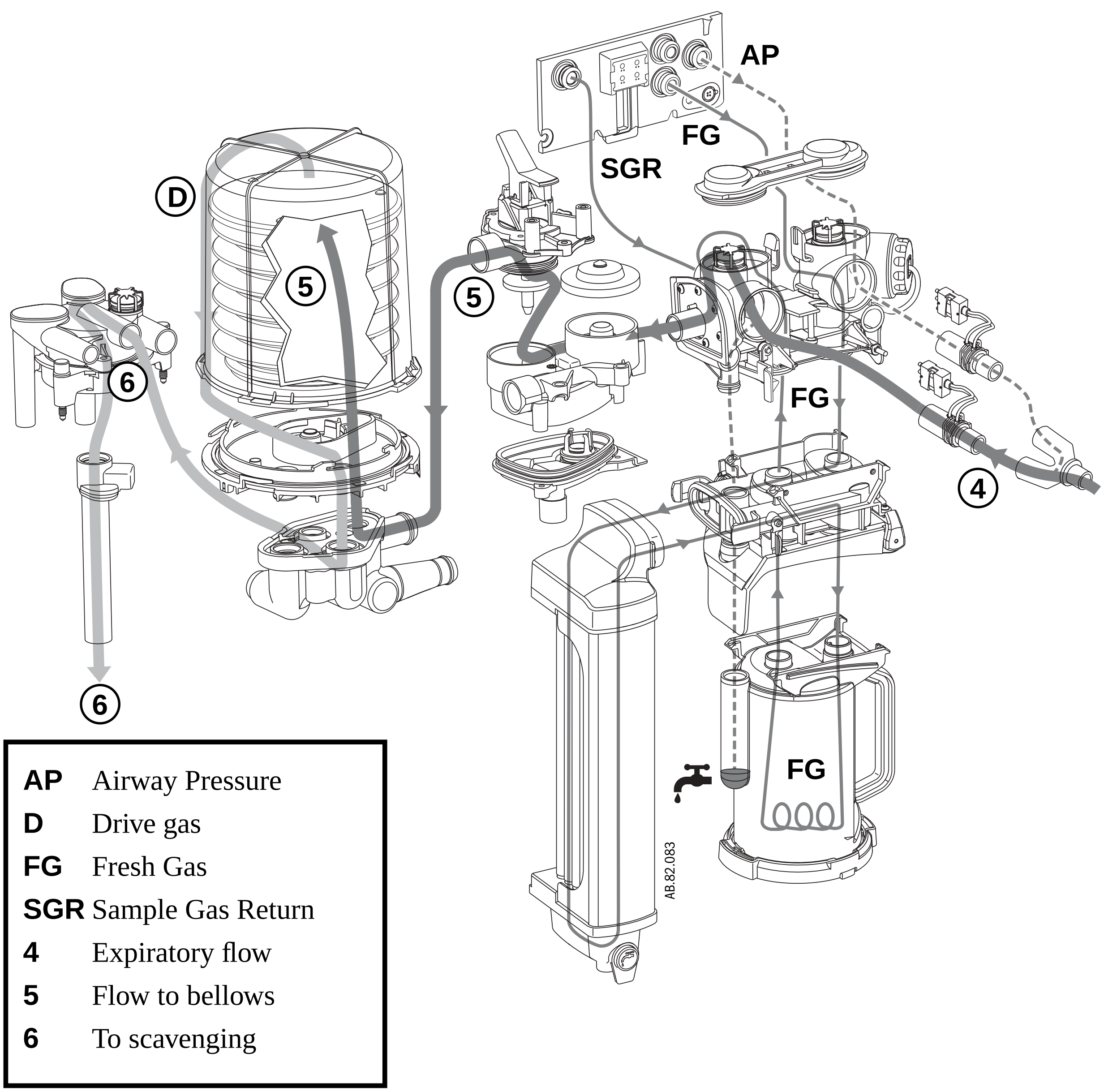


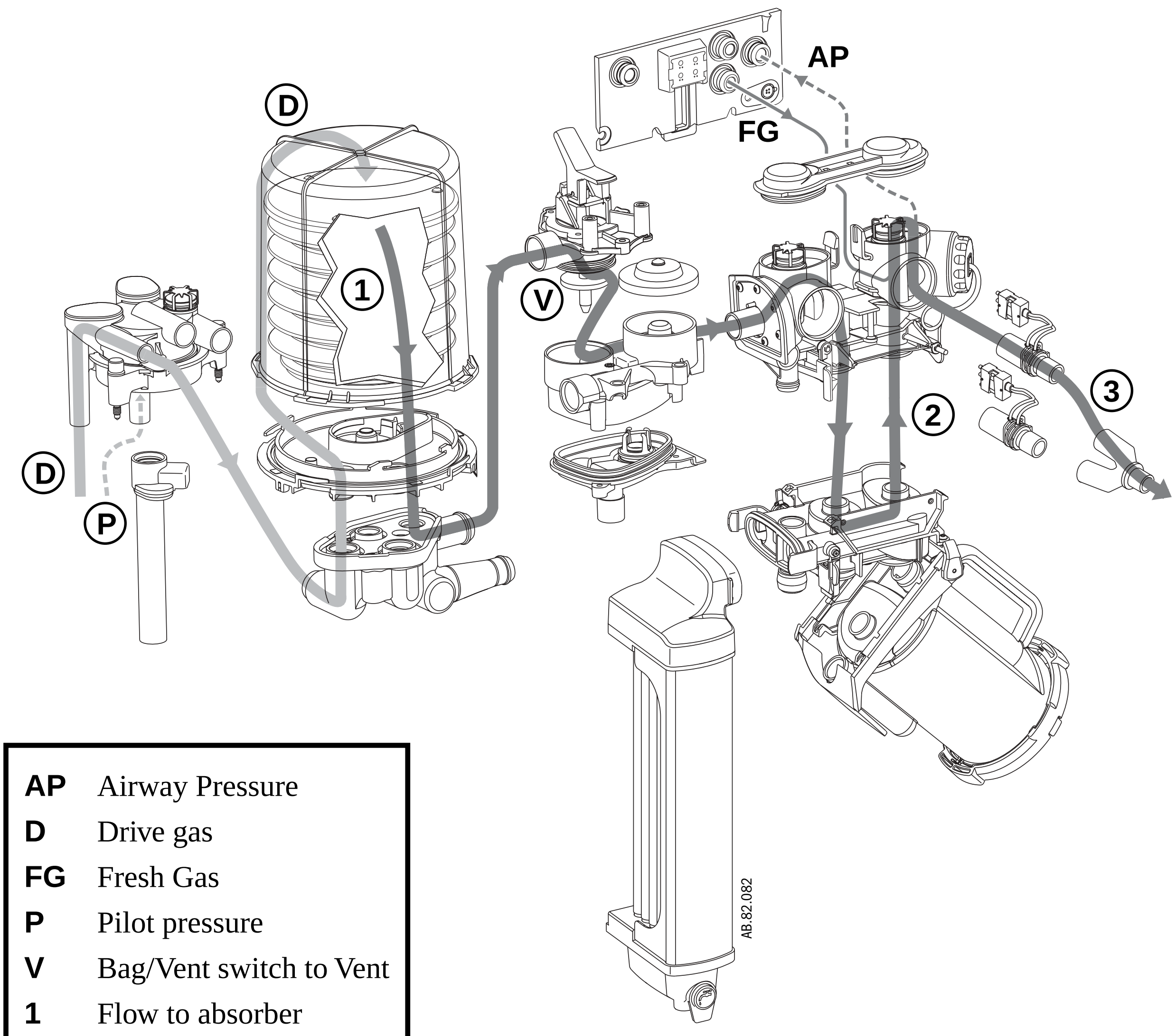
Figure 2-35 • Mechanical expiration through Condenser with EZchange Canister and Condenser ON

Mechanical inspiration (EZchange and condenser OFF)

The Bag/Vent switch closes the manual path (**V**). Pilot pressure (**P**) closes the exhalation valve.

Drive gas (**D**) pushes down on the bellows. Gas flows from the bellows (**1**), through the EZchange module bypassing the absorber (**2**), and through a unidirectional valve (inspiratory check valve) to the patient (**3**).

During inspiration, fresh gas flows into the inspiratory limb, upstream of the inspiratory check valve.



AP	Airway Pressure
D	Drive gas
FG	Fresh Gas
P	Pilot pressure
V	Bag/Vent switch to Vent
1	Flow to absorber
2	Bypass flow
3	Inspiratory flow

Figure 2-36 • Mechanical inspiration with EZchange Canister and Condenser OFF

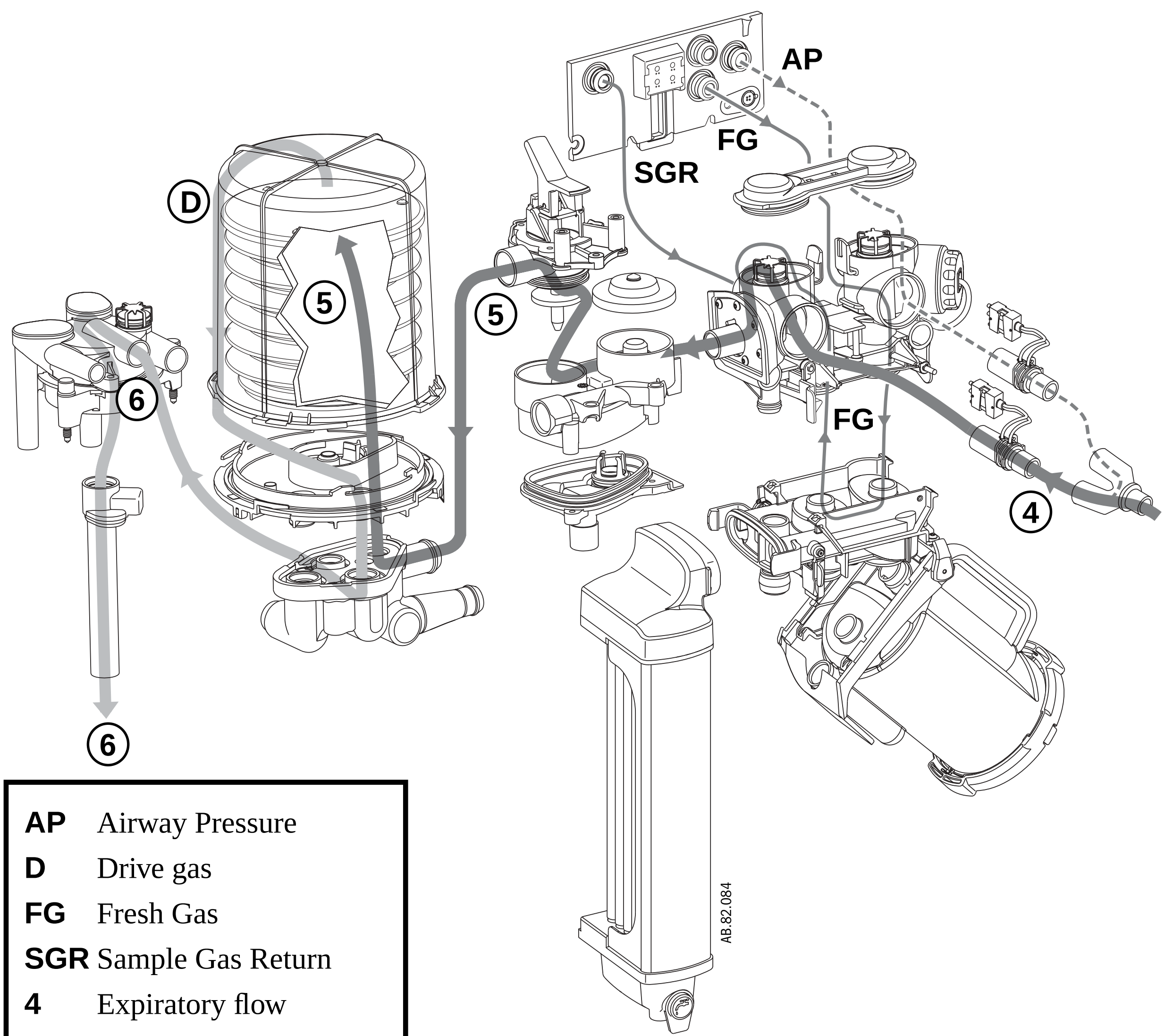
Mechanical expiration (EZchange and condenser OFF)

Drive-gas flow stops and the exhalation valve opens. Exhaled gas flows from the patient (**4**), through a unidirectional valve (expiratory check valve) and into the bellows (**5**). Residual drive gas (**D**) flows out of the bellows to the scavenging system (**6**).

If PEEP is selected, static pressure on the pilot port of the exhalation valve sets the PEEP level.

During exhalation, fresh gas flows backwards through the EZchange module (**FG**) into the expiratory limb, downstream of the expiratory check valve.

For machines that are plumbed to return sample gas to the breathing system, the returned gas (**SGR**) enters the breathing system after the expiratory check valve.

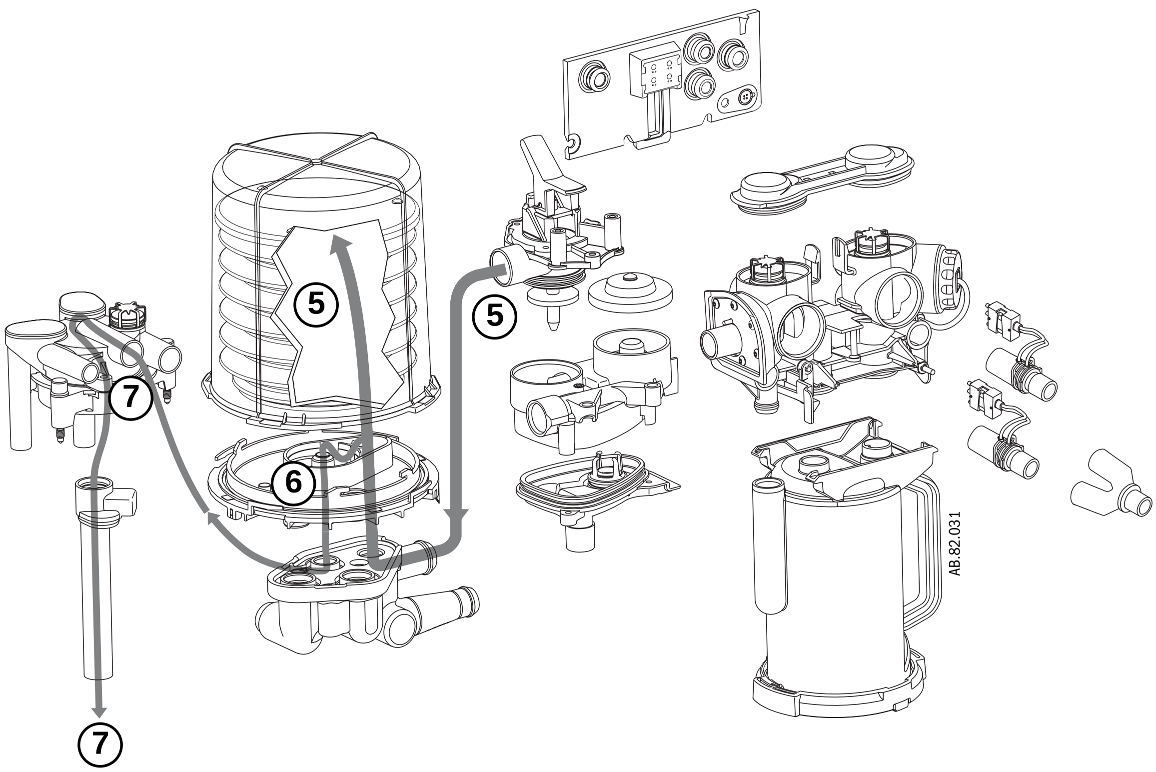


AP	Airway Pressure
D	Drive gas
FG	Fresh Gas
SGR	Sample Gas Return
4	Expiratory flow
5	Flow to bellows
6	To scavenging

Figure 2-37 • Mechanical expiration with EZchange Canister and Condenser OFF

Pop-off valve The pop-off valve limits the pressure inside the bellows to 2.5 cm H_2O above the drive gas pressure. This normally occurs when the bellows reaches the top of the housing at the end of exhalation (**5**).

Excess gas (**6**) vents to the scavenging system (**7**) through the pop-off valve and the exhalation valve.



5	Flow to bellows
6	Pop-off flow
7	To scavenging

Figure 2-38 • Flow through the pop-off valve

2.12.4 Fresh gas and O_2 flush flow (with SCGO)

To ABS (Circle) breathing system

Fresh gas (**1**) flows from the vaporizer manifold outlet to the SCGO assembly.

With the Circle system selected, fresh gas flow is channeled to Port 3 of the breathing system (before the inspiratory check valve).

The output of the O_2 Flush regulator (**2**) is channeled to the O_2 Flush valve. When activated, O_2 flush flow joins the fresh gas flow in the SCGO assembly.

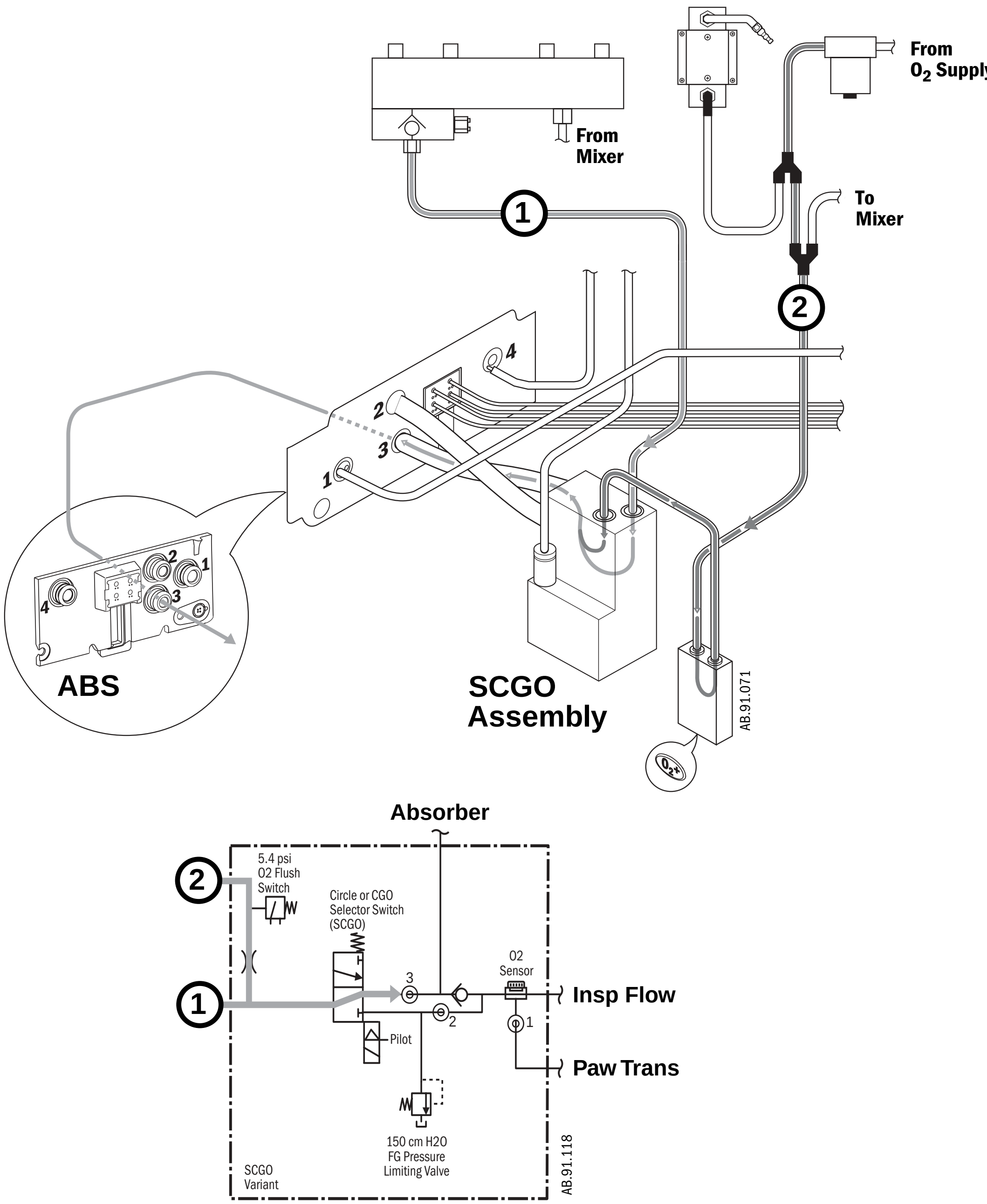


Figure 2-39 • Fresh gas and O_2 flush flow (to ABS)

Switched (Non-circle) Common Gas Outlet

Fresh gas (**1**) flows from the vaporizer manifold outlet to the SCGO assembly.

With the Non-Circle system selected, fresh gas flow is channeled to Port 2 of the breathing system (after the inspiratory check valve - to an external patient circuit through the Inspiratory port).

The output of the O_2 Flush regulator (**2**) is channeled to the O_2 Flush valve. When activated, O_2 flush flow joins the fresh gas flow in the SCGO assembly.

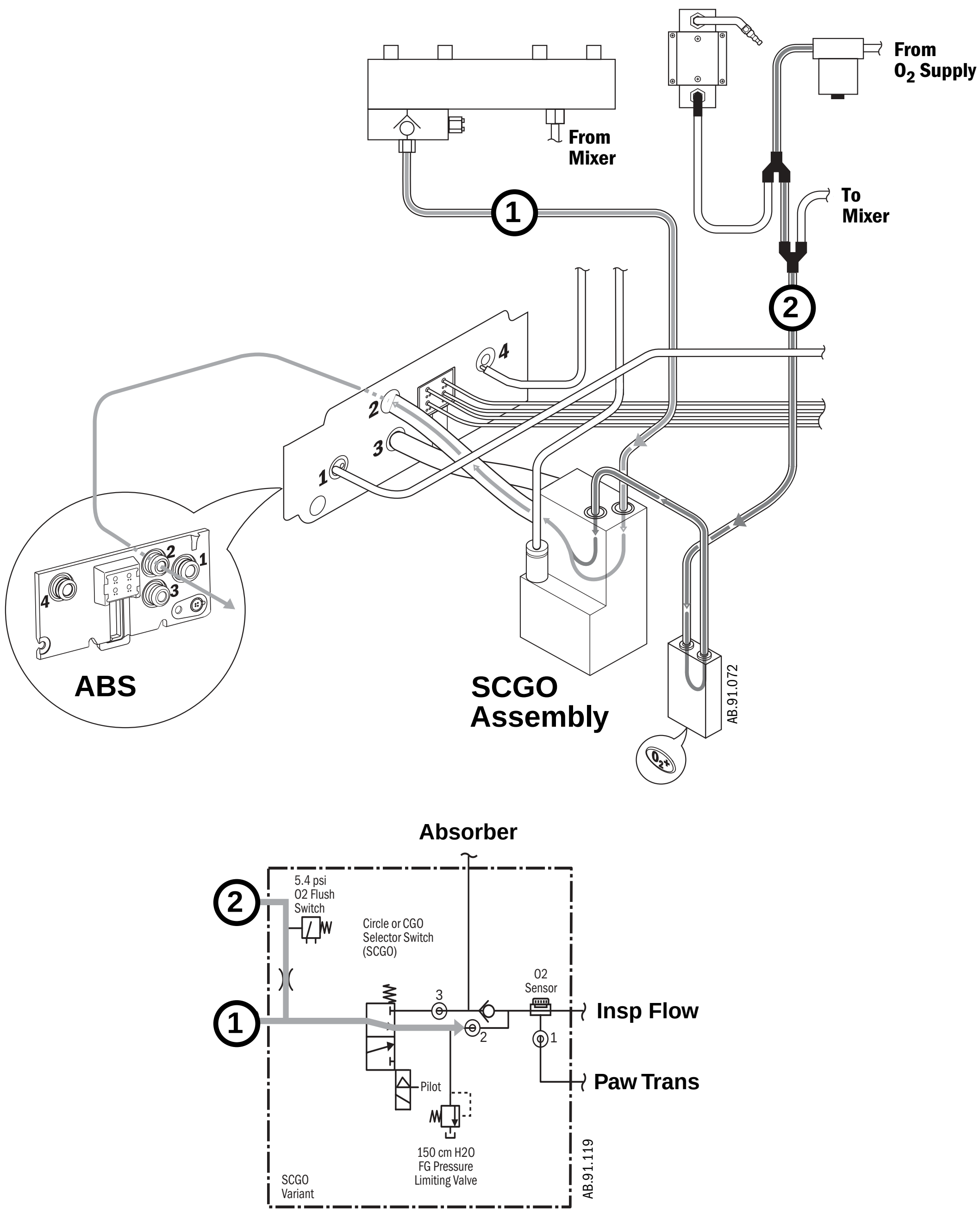


Figure 2-40 • Fresh gas and O_2 flush flow (to Insp port)

2.12.5 Fresh gas and O_2 flush flow (with ACGO)

To ABS (Circle) breathing system

Fresh gas (**1**) flows from the vaporizer manifold outlet to the ACGO Selector Switch.

With the ACGO Selector Switch in the ABS position, fresh gas flow is channeled to the breathing system.

The output of the O_2 Flush regulator (**2**) is channeled to the O_2 Flush valve. When activated, O_2 flush flow joins the fresh gas flow in the ACGO Selector Switch.

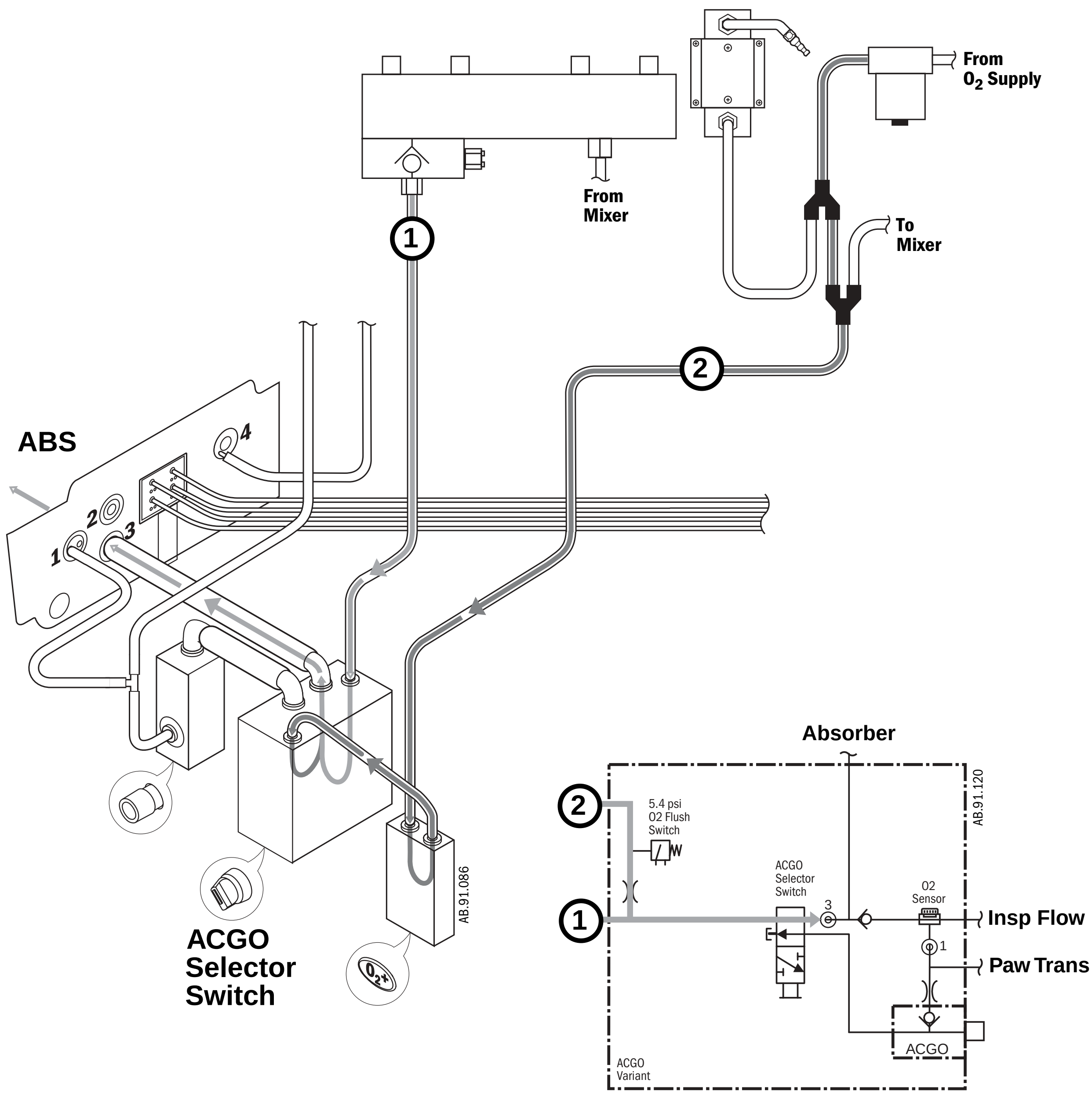


Figure 2-41 • Fresh gas and O_2 flush flow (to ABS)

Auxiliary (Non-circle) Common Gas Outlet

Fresh gas (**1**) flows from the vaporizer manifold outlet to the ACGO Selector Switch.

With the ACGO Selector Switch in the ACGO position, fresh gas flow is channeled to the ACGO outlet.

At the ACGO outlet, a small sample is diverted to the O_2 Cell in the ABS for O_2 monitoring.

The output of the O_2 Flush regulator (**2**) is channeled to the O_2 Flush valve. When activated, O_2 flush flow joins the fresh gas flow in the ACGO Selector Switch.

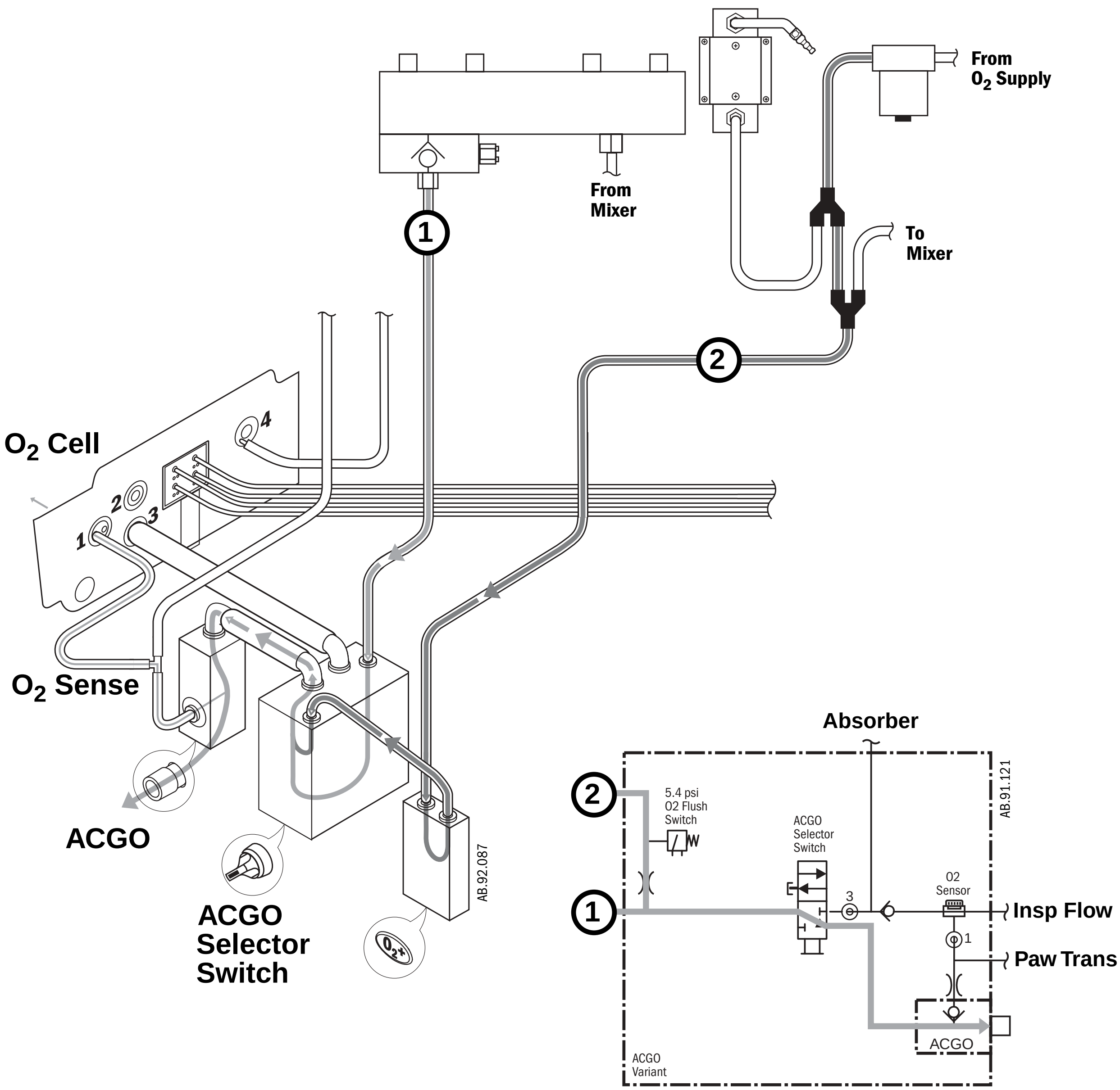


Figure 2-42 • Fresh gas and O_2 flush flow (to ACGO)

2.13 Ventilator mechanical subsystems

Refer to Figure 11-1, "*System circuit diagram*" in Section11, for the complete pneumatic/mechanical subsystem diagram.

The mechanical subsystems for the ventilator include:

Pneumatic Vent Engine

- Drive gas inlet filter
- Gas inlet valve
- Supply gas pressure regulator
- Flow control valve
- Drive gas check valve
- Mechanical Overpressure Valve (MOPV)
- Bleed resistor
- Free breathing valve

Exhalation valve

Bellows assembly

Breathing circuit flow sensors

2.13.1 Drive gas filter and Gas Inlet Valve

Drive gas (can be selected from O_2 or Air) enters the Vent Engine (**1**) at a pressure of 241 to 690 kPa (35 to 100 psi) through a 2-micron filter (**2**) that is located under the Gas Inlet Valve (**3**).

During normal operation the Gas Inlet Valve (GIV) is open to let supply gas flow. The GIV shuts off supply gas to the ventilator under failure conditions detected by the CPU or over-pressure switch. The output from the GIV stays at the filtered supply gas pressure.

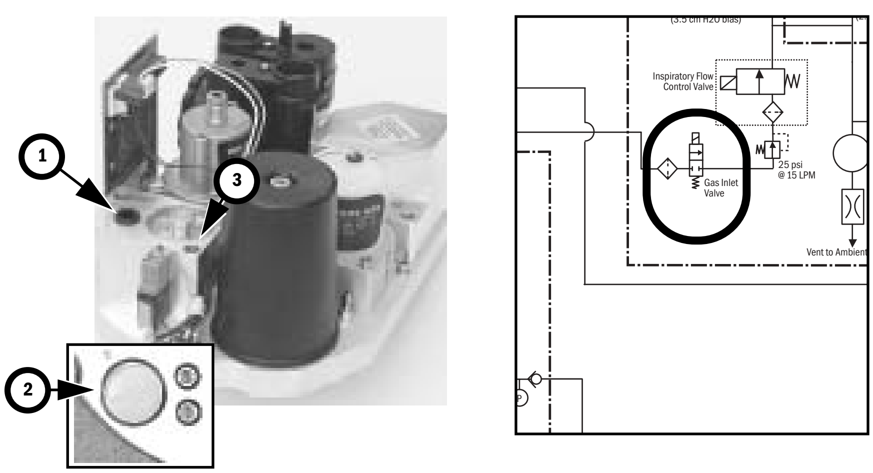


Figure 2-43 • Inlet filter and Gas Inlet Valve (GIV)

2.13.2 Pressure regulator

The pressure regulator (**4**) is a non-relieving pressure regulator that regulates high pressure filtered supply gas down to 172 kPa (25 psi).

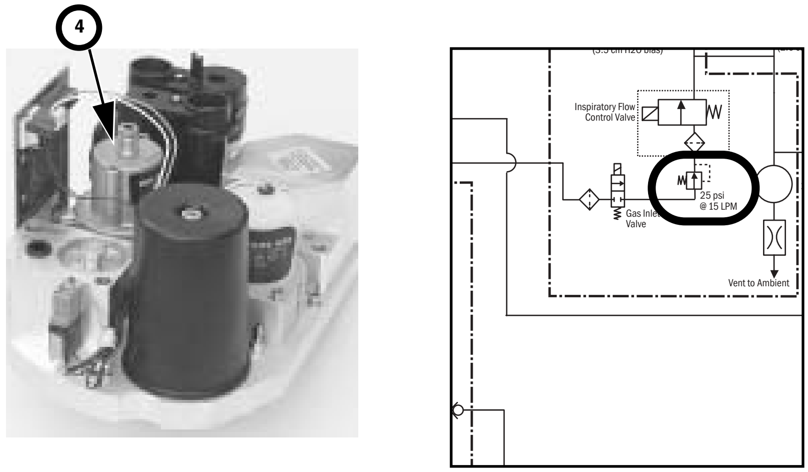


Figure 2-44 • Pressure regulator

2.13.3 Flow control valve

The flow control valve (**5**) is controlled by the CPU. Signals are sent to the flow control valve of the necessary flow determined by ventilator settings and sensor signals. The flow control valve modulates the incoming 172 kPa (25 psi) drive gases to an output from 0 to 120 liters per minute at pressures ranging from 0 to 100 cm H_2O.

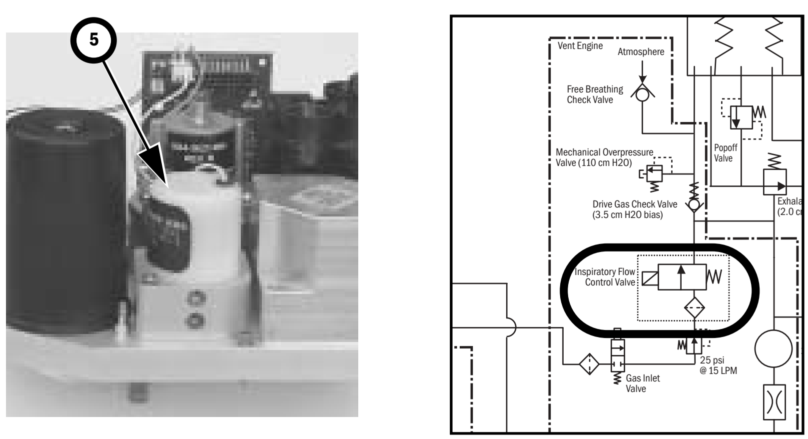


Figure 2-45 • Flow control valve

2.13.4 Drive Gas Check Valve (DGCV)

The Drive Gas Check Valve (**6**) is used downstream of the flow control valve to create the pilot pressure for closing the exhalation valve during inspiratory phases. The DGCV is biased shut by an integral weight that supplies approximately 3.5 cm H_2O of bias pressure before permitting flow downstream to the bellows assembly. When the ventilator is exhausting flow from the breathing circuit, the DGCV permits the exhalation valve pilot pressure to be de-coupled from the circuit pressure. This permits the exhalation valve to open and lets gas flow to the exhaust and the gas scavenging system.

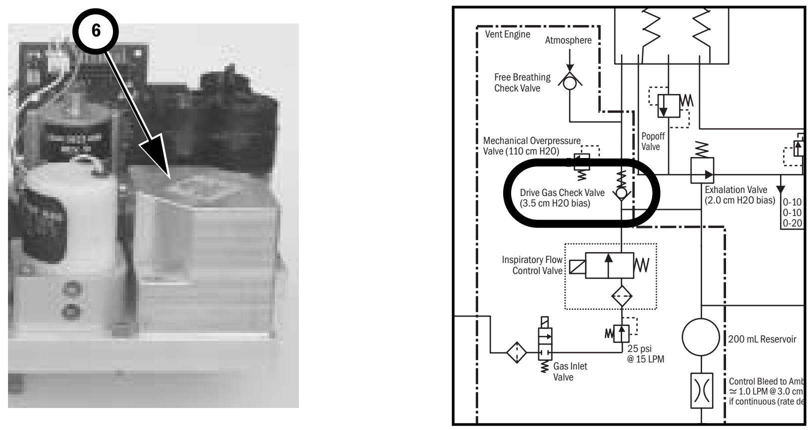


Figure 2-46 ▪ Drive Gas Check Valve

2.13.5 Bellows Pressure Relief Valve

The Bellows assembly is the interface between drive gas and patient gas in the breathing system. The pressure relief valve (or pop-off valve) in the bellows assembly (**7**) controls the pressure in the breathing circuit and exhausts excess patient gas through the exhalation valve.

The pressure relief valve is normally closed, maintaining approximately 1.5 cm H_2O in the breathing circuit in a no-flow condition, enough to keep the bellows inflated. It is piloted closed during inspiration and remains closed until the bellows is refilled during exhalation. It will exhaust ≤ 4 L/min excess fresh gas flow at ≤ 4 cm H_2O.

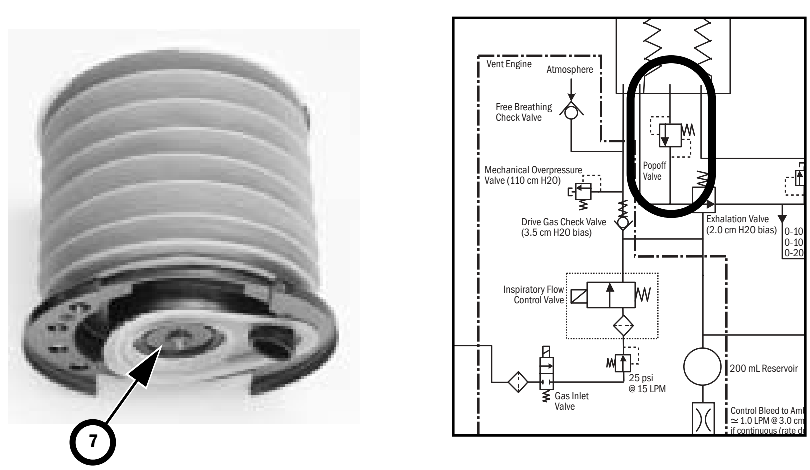


Figure 2-47 ▪ Bellows pressure relief valve

2.13.6 Exhalation valve

The exhalation valve contains an elastomeric diaphragm that is used along with the flow valve to control the pressures in the breathing circuit. The exhalation valve includes two male ports on the bottom for:

- Bellows drive gas (**8**)
- Exhalation valve pilot (**9**) - (manifold pressure)

The exhalation valve includes three ports on top that connect to the bellows base manifold:

- Drive gas pass through (**10**)
- Drive gas return and pop-off valve flow (**11**)
- APL exhaust flow to scavenging (**12**)

A port at the back of the exhalation valve (**13**) connects to the down tube that directs all the exhaust flows to the scavenging receiver.

The exhalation valve is normally open. Approximately 2 cm H_2O of pilot pressure is necessary to close the valve. When the exhalation port is open, gas flows from the bellows housing to the scavenging port.

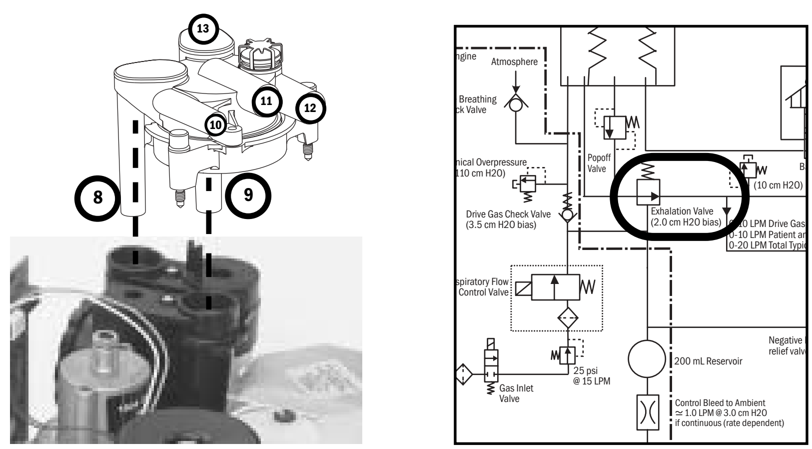


Figure 2-48 • Exhalation valve

2.13.7 Mechanical Overpressure Valve

The Mechanical Overpressure Valve (MOPV) is a mechanical valve (**14**) that operates regardless of electrical power. It functions as a third level of redundancy to the ventilator's pressure limit control functions, supplying pressure relief at approximately 110 cm H_2O.

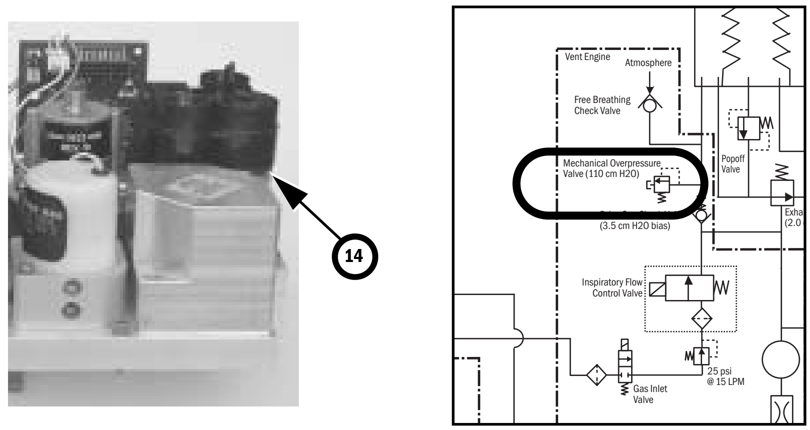


Figure 2-49 • Mechanical overpressure valve

2.13.8 Reservoir and bleed resistor

The reservoir (**15**) is a 200 ml chamber that dampens the manifold (pilot) pressure pulses to the exhalation valve.

The bleed resistor (**16**) is a “controlled leak” from 0 to 12 l/min in response to circuit pressures from 0 to 100 cm H_2O. The small quantity of pneumatic flow exhausting through the bleed resistor permits control of the exhalation valve's pilot pressure by modulation of the valve output. The bleed resistor exhausts only clean drive gas and must not be connected to a waste gas scavenging circuit. The output is routed away from the electrical components to make sure that systems using oxygen drive gas meet the 10VA limitation requirement for oxygen enrichment.

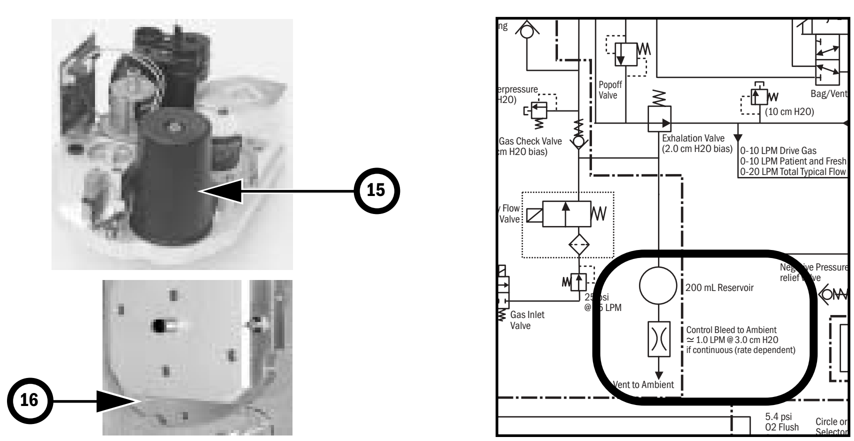


Figure 2-50 • Reservoir and bleed resistor

2.13.9 Free breathing valve

The free breathing valve (**17**) helps assure the patient can spontaneously breathe. The ventilator is programmed to supply a specified number of breaths per minute to the patient. If, in between one of these programmed cycles, the patient needs a breath (spontaneous), the free breathing valve permits the patient to inhale. The free breathing valve is closed on mechanical inspiration.

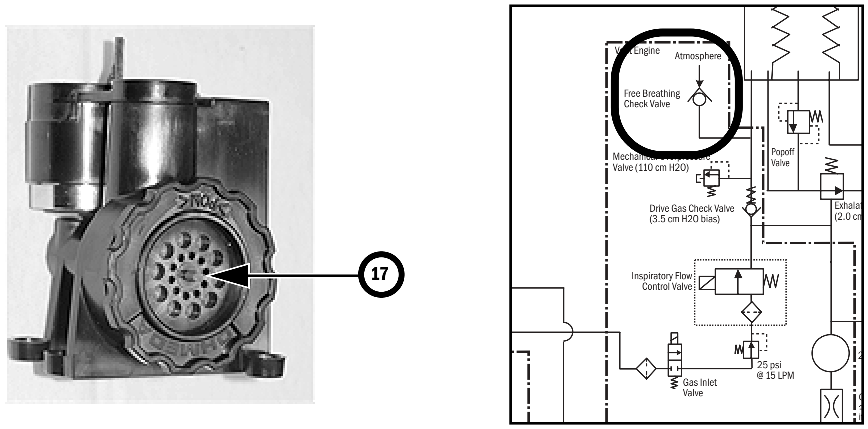


Figure 2-51 • Free breathing valve

2.13.10 Breathing circuit flow sensors

Two flow sensors are used to monitor inspiratory and expiratory gas flow:

- The inspiratory flow sensor is downstream of the breathing system inspiratory check valve.
- The expiratory flow sensor is located at the input to the breathin system expiratory check valve.

For System software prior to 5.0

Feedback from the inspiratory transducer is used to supply tidal volumes that make allowances for the effects of fresh gas flow and circuit compressibility.

Feedback from the expiratory flow sensor is used to supply signals for expiratory tidal volume monitoring and the breath rate.

For System software 5.0 or greater

Feedback from both the inspiratory and expiratory transducers is used to:

- supply tidal volumes that make allowances for the effects of fresh gas flow and circuit compressibility.
- supply signals for expiratory tidal volume monitoring and the breath rate.

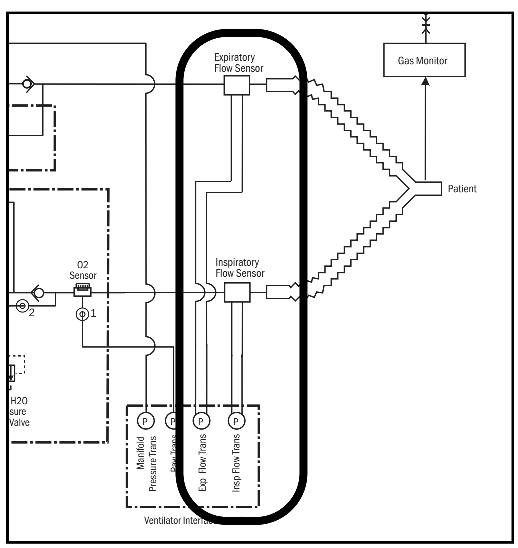


Figure 2-52 • Flow sensors

Notes

3 Checkout Procedure

In this section

⚠ **WARNINGS**

After any repair or service of the Avance system, complete all tests in this section.

Before you do the tests in this section:

- Complete all necessary calibrations and subassembly tests. Refer to the individual procedures for a list of necessary calibrations.
- Completely reassemble the system.

If a test failure occurs, make appropriate repairs and test for correct operation.

3.1 Inspect the system

⚠ CAUTION The upper shelf weight limit is 34 kg (75 lb).

⚠ WARNING Do not leave gas cylinder valves open if the pipeline supply is in use. Cylinder supplies could be depleted, leaving an insufficient reserve supply in case of pipeline failure.

Before testing the system, ensure that:

- The equipment is not damaged.
- Components are correctly attached.
- The breathing circuit is correctly connected, not damaged.
- Pipeline gas supplies are connected.
- Cylinder valves are closed.
- Models with cylinder supplies have a cylinder wrench attached to the system.
- Models with cylinder supplies have a reserve supply of O_2 connected to the machine during system checkout.
- The casters are not loose and the brakes are set and prevent movement.
- The power cord is connected to a wall outlet. The mains indicator comes on when AC Power is connected.

3.2 System checkout (for System software 3.X or greater)

For System software 2.X refer to Section 3.4.

3.2.1 Leak < 250 ml

The ***Leak < 250 ml*** setting is used during the circuit leak check portion of the checkout procedures. This check tests for leaks in the machine, breathing circuit, patient circuit, and manual bag. The default setting is ***No***.

Note Extraction of gas by external gas monitors may cause failure of the leak checks during tests.

When No is selected, the leak test will pass for leaks below 250 ml at 3 kPa (30 cmH_2O) pressure with no user interaction required. For leaks between 250 ml and 750 ml, the user can fix the leak and rerun the test or accept the leak and continue. For leaks above 750 ml, the test will fail and the user must fix the leak and rerun the test.

Set to ***Yes*** to quantify small leaks above 100 ml during the checkout procedures. Selecting ***Yes*** will display the measured leak at 3 kPa (30 cmH_2O) pressure and result in the test taking somewhat longer.

3.2.2 Machine Check

The machine check runs automatically and beeps to indicate when it is finished or if interaction is required.

The ***Machine Check*** does a:

- ***Machine Check - System*** check (Ventilator Circuit),
- ***Machine Check- Circuit*** check (Bag Circuit),
- and a ***Machine Check - Circuit O2*** cell check (if circuit O_2 cell is present).

When one of the checks is completed, the system will transition to the next check.

1. Turn the System switch to On.
2. Select ***Machine Check*** and follow the instructions.
3. If a check fails, follow the instructions to perform a recheck or accept the results.

3.2.3 Machine Check - System (Ventilator Circuit Testing)

The ***Machine Check-System*** checks the Bag/Vent switch, proper gas supply pressures, ventilator operation and leak, battery and electrical power, circuit compliance, flow control operation, and vaporizer operation. This is a two-step check.

1. Set the Bag/Vent switch to Vent.
2. Open the patient Y.
3. (ACGO option only.) Set the ACGO switch to Circle.
4. Select ***Start***. The display shows the checks being run.
   - The system beeps when this portion of the check is done.
   - The results are shown on the display.
5. Make sure the bellows is fully collapsed.
6. Occlude the patient Y.
7. Select ***Continue***. The display shows the checks being run.
8. When the check passes, the system will transition to the next step.

3.2.4 Machine Check - Circuit (Bag Circuit Testing)

The ***Machine Check-Circuit*** checks the Bag/Vent switch, proper gas supply pressures, airway pressure measurement transducer, APL valve, and manual circuit leak.

1. Occlude the patient Y.
2. Set Bag/Vent switch to Bag.
3. Set the APL valve halfway between 30 and 70.
4. (ACGO option only.) Set the ACGO switch to Circle.
5. Select ***Start***. The display shows the checks being run.
   - The system beeps when the check is done.
   - The results are shown on the display.
6. When the check passes, the system will transition to the next step.

3.2.5 Machine Check - Circuit O2

The ***Machine Check-Circuit O2*** check measures the O_2%.

1. Open the patient Y.
2. Set the Bag/Vent switch to Vent.
3. (ACGO option only.) Set the ACGO switch to Circle.
4. The display will show the O_2%. Do not select ***Done*** when 21 is first displayed. Allow the reading to stabilize, then select ***Done***. Calibrate the O_2 cell if necessary (measured reading outside 21% ±3%).

3.3 Individual Checks (for System software 3.X or greater)

Individual checks allow you to perform any combination of single checks. These checks are helpful if there is a specific problem/alarm and you want to test only that portion of the system.

The checks do not automatically move on to the next check.

3.3.1 System

The ***System*** check checks the Bag/Vent switch, proper gas supply pressures, ventilator operation and leak, battery and electrical power, circuit compliance, flow control operation, and vaporizer operation. This is a two-step check.

1. Set the Bag/Vent switch to Vent.
2. Open the patient Y.
3. (ACGO option only.) Set the ACGO switch to Circle.
4. Select ***Start***. The display shows the checks being run.
    - The results are shown on the display.
5. Make sure the bellows is fully collapsed.
6. Occlude the patient Y.
7. Select ***Continue***. The display shows the checks being run.
8. When the check passes, select ***Back***.
9. Select another check or select ***Start Case*** to go to the ***Start Case*** menu.

3.3.2 Circuit

The ***Circuit*** check checks the Bag/Vent switch, proper gas supply pressures, airway pressure measurement transducer, APL valve, and manual circuit leak.

1. Occlude the patient Y.
2. Set Bag/Vent switch to Bag.
3. Set the APL valve halfway between 30 and 70.
4. (ACGO option only.) Set the ACGO switch to Circle.
5. Select ***Start***. The display shows the checks being run.
6. When the check passes, select ***Back***.
7. Select another check or select ***Start Case*** to go to the ***Start Case*** menu.

3.3.3 Circuit O2 Cell

The ***Circuit O2 cell*** check measures the O_2%.

1. Open the patient Y.
2. Set the Bag/Vent switch to Vent.
3. (ACGO option only.) Set the ACGO switch to Circle.
4. The display will show the O_2%. Do not select ***Done*** when 21 is first displayed. Allow the reading to stabilize, then select ***Done***. Calibrate the O_2 cell if necessary (measured reading outside 21% ±3%).
5. Select another check or select ***Start Case*** to go to the ***Start Case*** menu.

3.3.4 Low P Leak

The positive pressure ***Low P Leak*** check measures machine leaks before the breathing system and between the gas mixer and the common gas outlet. It measures low pressure pneumatic leaks with a pass/fail limit of 50 ml.

1. Occlude the inspiratory (right-hand) port.
2. Select ***Start***.
3. The display shows the checks being run.
4. Open the inspiratory port and reconnect the breathing circuit.
5. Select another check or select ***Start Case*** to go to the ***Start Case*** menu.

3.3.5 Low P Leak (machines with ACGO)

The negative low P leak check measures machine leaks before the breathing system and between the gas mixer and the common gas outlet.

1. Make sure the ACGO switch is set to ACGO.
2. Attach the squeeze bulb to the ACGO outlet.
3. Squeeze (collapse) the bulb.
4. If the bulb inflates in less than 30 seconds, select ***Fail***.
5. If the bulb remains collapsed, select ***Pass***.
6. Remove the squeeze bulb from the ACGO outlet.

3.4 System “All checks” (for System software 2.X)

On the system “Checkout” menu, select ***All Checks*** and follow the instructions for *“Low P leak check”*, *“Quick check”*, *“Vent check”*, and *“Circuit O2 cell check”*.

If a check fails, follow the instructions on the display to perform a recheck or accept the results.

3.4.1 Low P leak check

The low P leak check looks for leaks between the mixer, vaporizer, and the inspiratory side of the breathing circuit.

For machines with SCGO:

1. Ensure the vaporizers are turned off.
2. Plug the inspiratory (right-hand) port.
3. Select ***Start***. The display shows the checks being run.
4. Repeat the check for each vaporizer with the vaporizer turned on.
5. When the checks pass, turn the vaporizer off.
6. Remove the plug from the inspiratory port.
7. Select ***Next*** to go to the next check.

For machines with ACGO:

1. Ensure the vaporizers are turned off.
2. Set the ACGO switch to ACGO.
3. Attach the “negative low-pressure leak test” device to the ACGO outlet.
4. Collapse the bulb (squeeze).
5. If the bulb inflates in < 30 seconds, there is a leak.
6. If the bulb remains collapsed, repeat the check for each vaporizer with the vaporizer turned on.
7. When the checks pass, turn the vaporizer off. Select ***Pass*** to go the next check.

3.4.2 Quick check

The quick check checks that the:

- Bag/Vent switch works in Bag position.
- Gas supply pressures are OK.
- Power cord is connected and the mains power is OK.
- Battery is fully charged.
- Manual circuit leak is OK.
- Flow controls operate correctly.

1. Occlude the patient Y piece.
2. Set the Bag/Vent switch to Bag.
3. Set the ACGO switch to Circle (ACGO option only).
4. Set the APL valve to approximately 50 (between the 30 and 70 marks).
5. Select ***Start***. The display shows the checks being run.
6. When the checks pass, select ***Next*** to go to the next check.

3.4.3 Vent check

The vent check measures circuit compliance and checks that the:

- Bag/Vent switch works in Vent position.
- Ventilator drive gas and O_2 pressure are OK.
- Ventilator circuit leak is OK.
- Ventilator delivers correctly.
- Alarms for ventilator failure or problems do not occur.

1. Set the Bag/Vent switch to Vent.
2. Open the patient Y piece.
3. Set the ACGO switch to Circle (ACGO option only).
4. Select ***Start***. The display shows time remaining for check.
5. When check passes, follow the instructions on the display.
6. Make sure the bellows is collapsed.
7. Occlude the patient Y piece.
8. Select ***Continue***. The display shows the checks being run.
9. When the checks pass, the circuit compliance is displayed.
10. Select ***Next*** to go to the next check.

3.4.4 Circuit O_2 cell check

The circuit O_2 cell check measures the O_2%.

1. Unplug the patient Y piece.
2. Set the Bag/Vent switch to Vent.
3. Set the ACGO switch to Circle (ACGO option only).
4. The display will show the O_2%.
5. Select ***Exit*** when measured O_2 is stable.
   O_2 cell calibration is recommended if displayed value is less than 21%.

3.5 Bellows drop test

1. End a case.
2. Set the Bag/Vent switch to Vent.
3. Occlude the patient Y piece.
4. Push the **O2 Flush** button until the bellows is full.
5. After the initial drop, if the bellows falls more than 100 ml/min, it has a leak.

3.6 Backlight test

1. Push the **Main Menu** key.
2. Select ***Calibration***.
3. Select ***Backlight Test***.
4. Select ***Start Test***.
5. The display will show the test running on light 1 and then on light 2. If the display goes completely blank or flickers during the test, one of the lights has failed.

3.7 Vaporizer back pressure test

WARNING Anesthetic agent comes out of the circuit during this test. Use a safe, approved procedure to collect and remove the agent.

1. Set the System switch to On.
2. Start a case.
3. Set the O_2 flow to 6 l/min.
4. Slowly adjust the vaporizer concentration from 0 to 1%.
   - Make sure that the O_2 flow stays constant.
   - Verify that the system continues to operate without issuing any related alarms.
5. Repeat the test for both vaporizer positions.

3.8 Pipeline and cylinder tests

1. Connect the pipeline supplies one at a time and ensure that the corresponding display indicates pipeline pressure.
2. Disconnect all pipeline supplies.
   a. Open each cylinder valve.
   b. Make sure that each cylinder has sufficient pressure. If not, close the applicable cylinder valve and install a full cylinder.
3. Test the cylinder supplies for a high pressure leak. Make sure that each cylinder has sufficient pressure:
   a. If equipped, turn the auxiliary O_2 flow control fully clockwise (no flow).
   b. If equipped, turn off venturi derived suction.
   c. Open each cylinder.
   d. Record the cylinder pressure.
   e. Close each cylinder valve.
   f. Record the cylinder pressure after one minute. If the pressure decreases more than indicated below, there is a leak.
      5000 kPa (725 psig) for ventilator drive gas.
      690 kPa (100 psig) for non ventilator drive gas.
      If a cylinder supply fails this test, install a new cylinder gasket and do this step again.
4. Close all cylinder valves.

⚠ **WARNING** Do not leave gas cylinder valves open if the pipeline supply is in use. Cylinder supplies could be depleted, leaving an insufficient reserve supply in case of pipeline failure.

3.8.1 O_2 supply alarm test

1. Establish O_2, Air, and (if equipped) N_20 gas supplies.
2. Set O_2 to 25% and (if equipped) N_20 as balance gas. For machines without N_2O, set Air as balance gas.
3. Set total flow to 3 L/min.
4. Stop the O_2 supply. (Disconnect the pipeline supply or close the cylinder valve.)
5. Make sure that:
   a. The low “O_2 supply pressure low” alarm occurs.
   b. The N_2O (if equipped) and O_2 flows stop.
   c. Air (if selected) flow continues or an Air selection prompt appears.
6. Reconnect the O_2 supply.

3.9 Pressure relief tests

To check the pressure relief valve in the vaporizer manifold outlet.

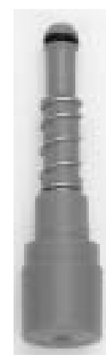
For machines with SCGO:

1. Remove the back cover to access the vaporizer manifold.
2. Remove the outlet tubing and connect a test device (pressure gauge or a digital manometer) to the vaporizer manifold outlet.
3. Adjust the O_2 flow to 0.5 L/min.
4. Verify that the test device reading stabilizes within the following range: **31–60 kPa** (**230–450 mm Hg**) (**4.5–8.5 psi)**.
5. Remove the test device and reconnect the outlet tubing.
6. Replace the back cover.

For machines with ACGO:

1. Set the ACGO selector switch to ACGO.
2. Connect a test device (pressure gauge or a digital manometer) to the ACGO outlet using the positive pressure leak test adapter.
3. Adjust the O_2 flow to 0.5 L/min.
4. Verify that the test device reading stabilizes within the following range: **31–60 kPa** (**230–450 mm Hg)** (**4.5–8.5 psi)**.
5. Remove the test device and the adapter.

Test Adapter

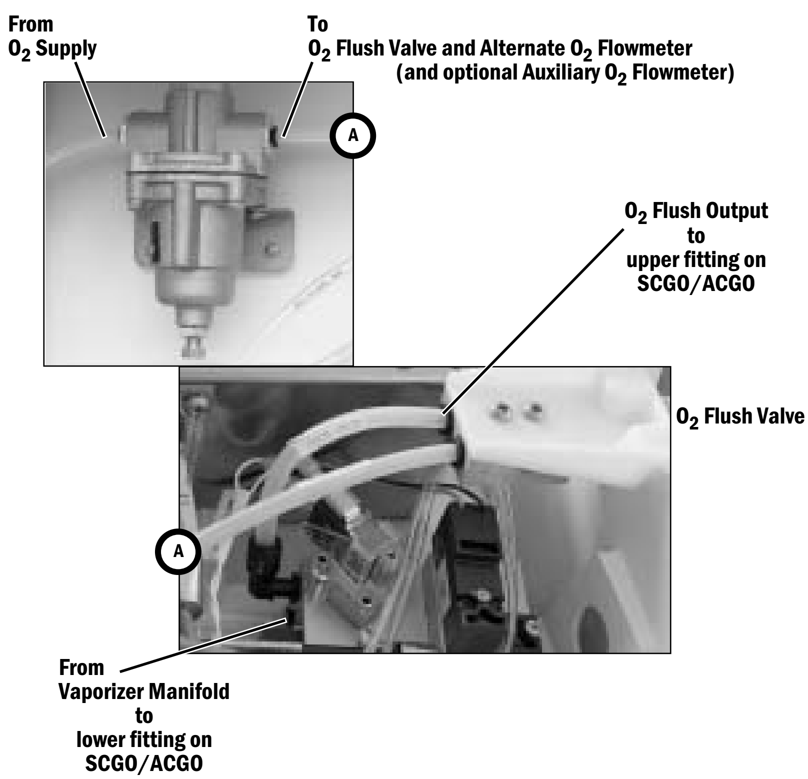


3.10 Flush Flow Test

1. With Bag/Vent switch in Bag, verify case has ended.
2. Set the Bag/Vent switch to Vent.
3. Attach a patient circuit and plug the patient port.
4. For ACGO equipped machines, set the ACGO selector switch to Circle.
5. Ensure that the bellows is completely collapsed.
6. Measure the amount of time it takes to fill the bellows when the O_2 Flush button is fully and continuously depressed.
7. Repeat the above measurement two more times (deflate bellows by removing the plug from the patient port).
    - The bellows should fill in 1.8 to 2.3 seconds.

Possible Causes of Failure

- Large leak (if long filling time).
- Flush regulator setting (Section 5.2).
- Flush regulator cross-connection (if long filling time).
- SCGO/ACGO selector valve inlet cross-connection (if short filling time).



3.11 Alarm tests

NOTE: If an Airway Gas Module is installed, ***FiO2*** readings are taken from the module instead of the O_2 sensor in the breathing circuit. When using an Airway Gas Module, a sample line must be connected to the patient circuit for testing the O_2 alarms.

1. Connect a test lung to the patient connection.
2. Start a case.
3. Set the Bag/Vent switch to Vent.
4. Set the O_2 concentration to 30%, and allow the O_2 reading to stabilize.
5. Test the O_2 alarms:
   - Set the ***FiO2 low*** alarm limit to 50%. Make sure an ***FiO2 low*** alarm occurs.
   - Set the ***FiO2 low*** alarm limit back to 21% and make sure that the ***FiO2 low*** alarm cancels.
   - Set the ***FiO2 high*** alarm limit to 50%.
   - Push the O_2 flush button.
   - Make sure the ***FiO2 high*** alarm occurs.
   - Set the ***FiO2 high*** alarm limit back to 100%. Make sure that the ***FiO2 high*** alarm cancels.
6. Test the ***MVexp low*** alarm:
   - Go to the ***Alarm Setup*** menu.
   - Set the ***MV low*** alarm limit to greater than the measured minute volume.
   - Make sure that a ***MVexp low*** alarm occurs.
   - Set the ***MV low*** alarm limit to off.
7. Test the ***Ppeak high*** alarm:
   - Set the ***Pmax*** to less than the peak airway pressure.
   - Make sure that the ***Ppeak high*** alarm occurs.
   - Set the ***Pmax*** to the desired level.
8. Test the ***PEEP high. Blockage?*** alarm:
   - Close the APL valve.
   - Set the Bag/Vent switch to Bag. Mechanical ventilation stops.
   - Block the patient connection and push the O_2 flush button.
   - Make sure that the ***PEEP high. Blockage?*** alarm occurs after approximately 15 seconds.
9. Test the ***Ppeak low. Leak?*** alarms:
   - Unblock the patient connection.
   - Set the Bag/Vent switch to Vent.
   - Set the tidal volume and total flow to minimum.
   - Other alarms such as ***MVexp low*** can occur.
   - Make sure that the ***Ppeak low. Leak?*** alarms occur.
10. Set all alarm limits to approved clinical values.

3.12 Alternate O_2 flowmeter tests

1. Open the O_2 cylinder valve or connect an O_2 pipeline.
2. Rotate the Alt O_2 flow control fully clockwise to minimum flow.
3. Press the Alternate O_2 switch to turn on Alternate O_2 flow.
   The flowmeter should indicate 0.5 to 0.7 L/min.
4. Rotate the flow control counterclockwise (increase). The ball should rise immediately after rotation is begun. It should rise smoothly and steadily with continued counterclockwise rotation. When a desired flow is set, the ball should maintain in a steady position.
5. Rotate the flow control clockwise to minimum flow.
6. Press the Alternate O_2 switch to turn off Alternate O_2 flow; confirm yes.

3.13 Auxiliary O_2 flowmeter tests

1. Open the O_2 cylinder valve or connect an O_2 pipeline.
2. Rotate the flow control clockwise (decrease) to shut off the flow. The ball should rest at the bottom of the flow tube and not move.
3. Rotate the flow control counterclockwise (increase). The ball should rise immediately after rotation is begun. It should rise smoothly and steadily with continued counterclockwise rotation. When a desired flow is set, the ball should maintain in a steady position.
4. Occlude the auxiliary O_2 outlet. The ball should rest at the bottom of the flow tube and not move. A ball that does not rest at the bottom of the flow tube indicates a leak and requires service.
5. Rotate the flow control clockwise to shut off the flow.

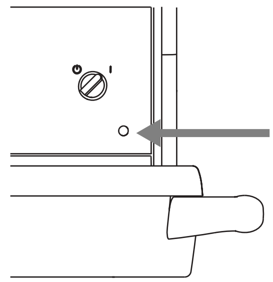
3.14 Integrated Suction Regulator tests

The gauge needle should come to rest within the zero range bracket when no suction is being supplied. Gauges which do not comply may be out of calibration.

1. Adjust the regulator setting to minimum.
2. Turn the mode selector to I (On).
3. Ensure the gauge remains less than 200 mmHg (26 kPa, 0.26 Bar).
4. Occlude the inlet.
5. Ensure the gauge remains less than 200 mmHg (26 kPa, 0.26 Bar).
6. Adjust the regulator in an increasing vacuum level.
7. The gauge should rise after rotation has begun. The gauge should rise with continued rotation of the regulator adjustment.
8. Adjust the regulator setting to minimum.
9. Turn the Mode selector to O (Off).

3.15 Power failure test

1. Connect the power cord to a wall outlet. The mains indicator on the front panel comes on when AC Power is connected.



2. Set the system switch to On and Start a case.
3. Unplug the power cord with the system turned on.
4. Make sure that the power failure alarm comes on.
5. Make sure the following message is displayed:
   - Plug in power cable. On battery
6. Connect the power cable again.
7. Make sure the alarm cancels.

3.16 Electrical safety tests

Make sure the system is completely assembled and all accessory devices are connected to electrical outlets.

1. Connect an approved test device (e.g. UL, CSA, or AAMI) and verify that the leakage current is less than:

Voltage	Max. Leakage Current
120/100 Vac	300 μAmps
220/240 Vac	500 μAmps

2. Make sure that the resistance to ground is less than 0.2Ω between an exposed metal surface and the ground pin on the power cord.

4a Installation and Service Menus (DU)

In this section

4a.1 Service and Installation menu structure

This section describes the Service level functions that are part of the main software installed in the anesthesia machine.

Section 8a, "*Service Diagnostics and Software Download (DU)*," covers a separate service application that loads from a PCMCIA card and is used to download system software and run service diagnostics and other service tests.

Menu structure

The Service menu structure has three levels which are password protected:

- Install/Service (super-user)
- Installation
- Service

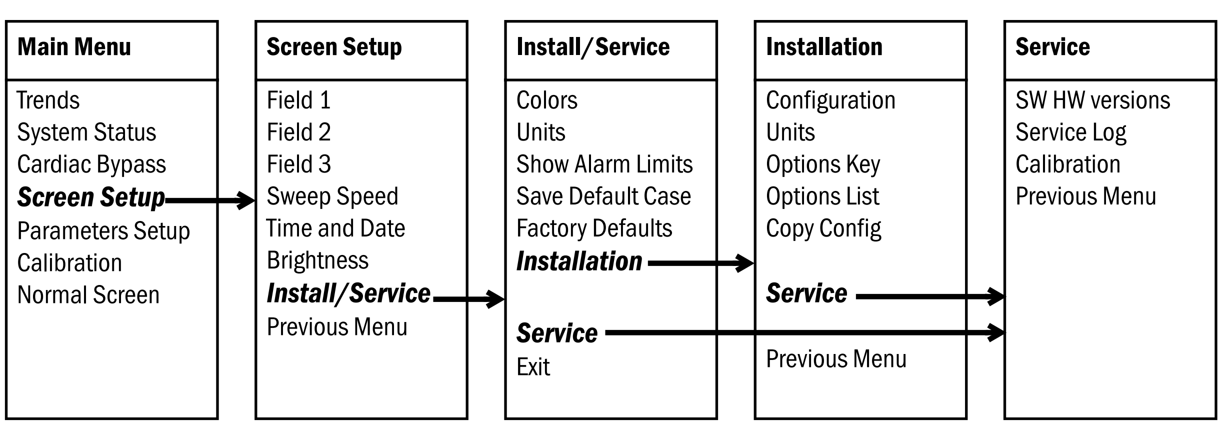
The **Install/Service** level (super-user password) supports standard hospital preferences: choosing units; setting ventilator, alarm, and gas delivery defaults.

The **Installation** level requires the service password and supports language, gas color codes, flow tube position, country, hardware flags for system components (acgo or scgo etc.), enabling software options, and cloning a system.

The **Service** level requires the service password and supports diagnostic tools and automated component tests.

Follow the menu structure to access the various service screens:

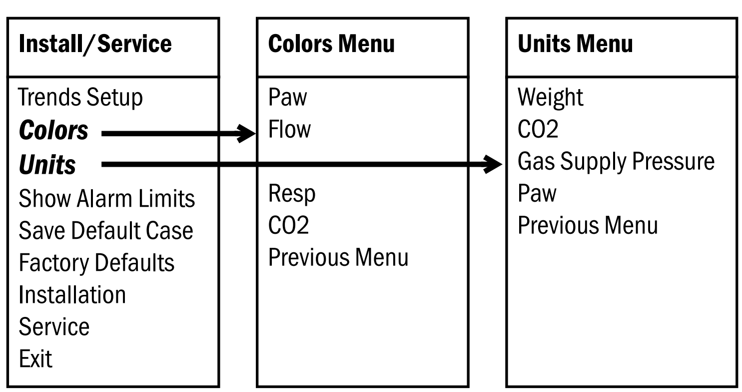
- on the **Main Menu**, select **Screen Setup**;
- on the **Screen Setup** menu, select **Install/Service** to access the Install/Service (with super-user password) menu;
- on the **Install/Service** menu, select **Installation** (with service password) to access the Installation menu.
- to access the Service menu, select **Service** (with service password) on the **Install/Service** menu; or, from the **Installation** menu, select **Service** to access the same Service menu without having to enter the service password.



4a.2 Install/Service Menu (Super User)

Use the super-user password to access the Install/Service menu: "16-4-34."

Menu Item	Message text	Comments
Colors	Set colors of parameters.	
Units	Set units of weight, CO2, gas supply pressure, and Paw.	
Show Alarm Limits	Select yes to show alarm limits in digit fields.	Default is Yes
Save Default Case	Save normal screen, air/ N2O, circuit type, ventilator settings, and alarm limits from the last case as defaults	Last used alarm settings (including hide/ show alarm limits), screen layout (middle waveform selection, sweep speed, scaling), ventilator mode and setting, balance gas, and start case gas outlet selection are saved as facility defaults. **Note:** The Pmax alarm limit shall not be saved higher than 40 cmH2O. The low FiO2 alarm limit shall not be saved lower than 21%.
Factory Defaults	Return to default factory settings. After selecting Factory Defaults: "Reset machine for defaults to take effect."	Action: All facility defaults get replaced with factory defaults. Super User settings also get set to Factory Defaults. No Service level configuration settings are changed.
Installation	Set language, gas colors, hardware, and enable options.	Navigate with password to Installation menu. Password is "26-23-8"
Service	Show technical data for troubleshooting and calibration.	Navigate with password to Service menu. Password is "26-23-8"
Exit	Turn power off to exit the service and super user menus.	



4a.2.1 Colors Menu

Menu Item	Message text	Values
Paw	Change color of Paw waveform, digits and trend.	Yellow, White, Green, Red, or Blue
Flow	Change color of Flow waveform, Flow and Volume digits and trends.	Yellow, White, Green, Red, or Blue
Resp	Change color of respiration, digits and trend.	Yellow, White, Green, Red, or Blue
CO2	Change color of CO2 waveform, digits and trend.	Yellow, White, Green, Red, or Blue
Previous Menu	Return to previous menu.	

4a.2.2 Units Menu

The Units menu can be accessed here in the super-user level to change individual preferences, or if required during installation, in the service level Installation menu.

Menu Item	**Message text**	**Values**
Weight	Change weight unit: kg or lb.	kg or lb
CO2	Change CO2 unit: %, kPa, or mmHg.	%, kPa, or mmHg;
Gas Supply Pressure	Change gas supply pressure unit: kPa, psi, or bar.	psi, kPa, or bar
Paw	Change Paw unit: kPa, hPa, cmH2O, mmHg, mbar.	kPa, hPa, cmH2O, mmHg, or mbar
Previous Menu	Return to previous menu.	

4a.2.3 Factory Defaults

The following table lists the factory defaults for parameters and alarm limits:

Parameter	Value
Vent Mode	VCV
TV (tidal volume)	500 ml
Pinsp	5 cmH2O (5 hPa, 0.5 kPa, 5 mbar, 3.6 mmHg)
RR	12 /min
Mech RR	12 /min
Tinsp	1.70
I:E	1:2.0
Trig. Window	25%
Flow Trig.	2 l/min
End Breath	25%
Psupport	Off
PEEP	Off
Tpause	Off
Backup Time	30 s
O2%	100%
Balance Gas	Air
Circuit	Circle
Gas Outlet installed	SCGO
Paw Color	Yellow
Flow Color	Green
Resp Color	White
CO2 Color	White
Paw Units	cmH2O
Weight Units	kg
Temperature Units	C
CO2 Units	%
Altitude	300 m
Gas Supply Pressure Units	kPa
Decimal marker	. <dot>
Language	English
Gas Supply Colors	ISO (O2 = white, N2O = blue, Air = blk/wht)
O2 flow tube	Right side
Vent drive gas	O2
PSV Pro	Enabled
SIMV/PSV	Enabled
PCV	Enabled
SIMV-PC	Enabled
N2O enabled	No

Alarm Limit	Value
Pmax High	40 cmH2O (40 hPa, 4 kPa, 40 mbar, 30 mmHg)
MV High	10 l/min
MV Low	2 l/min
TV High	1000 ml
TV Low	Off
RR High	Off
RR Low	Off
Et CO2 High	6.5% (50 mmHg or 6.5kPa)
Et CO2 Low	Off
Fi CO2 High	Off
Fi O2High	Off
Fi O2 Low	21%
EtO2 High	Off
EtO2 Low	Off
Fi Iso High	5%
Fi Iso Low	Off
Et Iso High	Off
Et Iso Low	Off
Fi Sev High	8%
Fi Sev Low	Off
Et Sev High	Off
Et Sev Low	Off
Fi Des High	15%
Fi Des Low	Off
Et Des High	Off
Et Des Low	Off
Fi Enf High	5%
Fi Enf Low	Off
Et Enf High	Off
Et Enf Low	Off
Fi Hal High	5%
FI Hal Low	Off
Et Hal High	Off
Et Hal Low	Off

4a.3 Installation Menu

Use the service-level password to access the Installation menu: “26-23-8.”

Whenever the installation menu is entered, “Enter Service dd-mmm-yyyy hh:mm:ss” is recorded in the Event log.

Menu Item	Message text
Configuration	Set language, gas color code, and O2 flowmeter position.
Units	Set units.
Options Key	Enable software options.
Options List	Display software options.
Copy Config	Normal Message “Save or install configuration and default settings using memory card.” Blocked Message “Please insert memory card.”
Service	Show error, event, and alarm logs. (Accessing the Service menu from the Installation menu does not require second use of service password.)
Previous Menu	Return to previous menu.

Configuration
Decimal Marker
Language
Gas supply Colors
O2 Flowtube
Ventilator Drive Gas
Altitude
Gas Outlet
N2O Enabled

Units Menu
Weight
CO2
Gas Supply Pressure
Paw

Options Key
Current Key
Entry 1
Entry 2
Entry 3
Entry 4
Entry 5
Entry 6
Entry 7
Save New Key
Control Board ID

Options List
Available Options
SIMV/PSV
PCV
PSV Pro

Copy Configuration
Save to Card
Copy from Card

4a.3.1 Configuration

Menu Item	Message text	Values	Comments
Decimal Marker	Select decimal delineator.	0.01, 0 01 or 0,01	
Language	Change language translation of screen texts.	English, French, German, Spanish, Italian, Japanese, Portuguese, Dutch, Chinese (simplified), Finnish, Norwegian, Hungarian, Polish, Greek, Czech, Turkish, and Russian.	Default: English
Gas supply Colors	Change color of O2, N2O, and Air.	ANSI, ISO, Neutral	ANSI: O2 green, Air yellow, N2O blue; ISO: O2 white, Air black/white, N2O blue; Neutral: All gases white.
O2 Flowtube	O2 on left or right-hand side.	Left, Right	
Ventilator Drive Gas	Change drive gas to match machine configuration.	Air, O2	
Altitude	Change altitude used for gas calculations.	–400 to 3000 m in 100-m increments	
Gas Outlet*	Change type of fresh gas outlet.	SCGO, ACGO	SCGO: Use insp port. ACGO: Use auxiliary port.
N2O Enabled	Change to match machine configuration.	Yes; No	

* For machines without a separate auxiliary common gas outlet and selector switch, set ***Gas Outlet*** to SCGO: Selectable Common Gas Outlet.

* For machines with an external auxiliary common gas outlet and selector switch, set ***Gas Outlet*** to ACGO: Auxiliary Common Gas Outlet

4a.3.2 Units Menu

This is the same menu that is accessible from the super-user Install/Service menu.

Menu Item	Message text	Values
Weight	Change weight unit: kg or lb.	kg or lb
CO2	Change CO2 unit: %, kPa, or mmHg.	%, kPa, or mmHg
Gas Supply Pressure	Change gas supply pressure unit: kPa, psi, or bar.	psi, kPa, bar
Paw	Change Paw unit: kPa, hPa, cmH2O, mmHg, mbar.	kPa, hPa, cmH2O, mmHg, or mbar

4a.3.3 Options Key

The Options Key menu is used to configure the software to include the features that the customer has purchased. The included features are shown in the Options List menu.

Options Key menu

Menu Item	Message text	Values
Current Key	Enter key code to enable options.	XXXAXBC
Entry 1	Enter first entry of key-code.	0 to 9, A to Z, ~, !, @, #, $, %, ^, *, (,), ?
Entry 2	Enter second entry of key-code.	
Entry 3	Enter third entry of key-code.	
Entry 4	Enter fourth entry of key-code.	
Entry 5	Enter fifth entry of key-code.	
Entry 6	Enter sixth entry of key-code.	
Entry 7	Enter seventh entry of key-code.	
Save New Key	Confirm entries for key-code.	
Control Board ID	Control number used by key-code.	XXX

When options are added, “Add <option> dd-MMM-yyy hh:mm:ss” is written to the event log.

If more than one option is added, each option is be listed separately.

Options List menu

The options list shows which options are enabled.

Menu Item	Message text	Values
Available Options		
SIMV/PSV	SIMV vent w/pressure support.	On, Off
PCV	Pressure controlled ventilation.	On, Off
PSV Pro	Pressure support ventilation w/backup.	On, Off

4a.3.4 Copy Configuration

Copy Configuration menu

Menu Item	Message text	Values	Comments
Save to Card	Save Configuration and defaults to card.	<blank>, Fail, or OK. The field is blank until the data has either been written to the card (OK) or the system determines it cannot write to the card (Fail).	Saves all settings that are not hardware dependent, including facility defaults, colors, units, O2 flow tube position, decimal marker, and altitude.
Copy from Card	Copy Configuration and defaults from card. When completed: Copy from card complete. Please reboot system.	<blank>, Fail, or OK. The field is blank until the data has either been read from the card (OK) or the system determines it cannot read the card or the card does not have the required data (Fail).	

Systems cannot accept configuration files from a different product model.

The software version is stored with the saved configuration. A system will reject any configurations from other than the current version of software.

Selecting Save to Card overwrites any configuration on the card.

4a.4 Service Menu

Use the service-level password to access the Service menu: “26-23-8.”

Whenever service menu is entered, “Enter Service dd-mmm-yyyy hh:mm:ss” is recorded in the Event log.

Menu Item	Message text
SW HW versions	Scroll through system information.
Service Log	Show error, event, and alarm histories.
Calibration	Push ComWheel to perform service calibrations.
Previous Menu	Return to previous menu.

SW HW Versions
Total Time:
Software Release:
Model Code:
Machine Serial Number:
Option Package:
Option Code:
Anes Hardware . . .
Disp Hardware . . .
Mixer Hardware . . .
Vent Hardware . . .
Power Hardware . . .
MGas Hardware . . .

Service Log Menu
Scroll Recent
Error History
Event History
Alarm History
Copy Logs
Reset Logs
Previous Menu

Calibration
Instructions
User Calibration
Manifold P Span
Insp Flow Zero
Insp Flow Valve
Bleed Resistor
Paw Span
Zero Gas Xducer
Cal Config
Previous Menu

4a.4.1 Software/ Hardware Ver Menu

Turn the ComWheel to scroll through the list box.

Push the ComWheel to return to the Service menu.

System Information menu

List box text with X=Number, A, B, C = letter
Total Time: XXXXX (Minutes)
Software Release: XX.XX
Model Code: XXX
Machine Serial Number: ABCDXXXXX
Option Package: XXX
Options Code: XXXXX
Anes Software Version: XX.XX
Anes Hardware Version: XXXX-XXXX-XXX REV A
Anes Board Serial Number: ABCXXXXX
Disp Software Version: XX.XX
Disp Hardware Version: XXXX-XXXX-XXX REV A
Disp Hardware Serial Number: ABCXXXXX
Mixer Software Version: XX.XX
Mixer Hardware Version: XXXX-XXXX-XXX REV A
Mixer Board Serial Number: ABCXXXXX
Mixer O2 Flow Sensor Serial Number: XXXXXXXXX
Mixer Balance Gas Flow Sensor Serial Number: XXXXXXXXX
PCA Serial Number: ABCXXXXX
Vent Software Version: XX.XX
Vent Hardware Version: XXXX-XXXX-XXX REV A
Vent Intf Board Serial Number: ABCXXXXX
Power Software Version: XX.XX
Power Hardware Version: XXXX-XXXX-XXX REV A
Power Board Serial Number: ABCXXXXX
MGas Software Version: X.X
MGas Hardware Version: GAS SW Pr. XXXXXXX-X
MGas Hardware Serial Number: ABCXXXXX

The MGas information is only displayed when an Airway module is present.

4a.4.2 Service Log Menu

The Service log menu is an organized listing of stored events.

Menu Item	Message text
Scroll Recent	Scroll through newest entries.
Error History	Show error history.
Event History	Show event history.
Alarm History	Show alarm history.
Copy Logs	Copy logs to PCMCIA card. Takes about 1 minute.
Reset Logs	Erase Error and Alarm log entries
Previous Menu	Return to previous menu.

Each history log shows at the top of the screen the total “Running Hours” and the date when the logs were last reset. The running hours number is the same number as the operating hours shown on the system status page during normal operation.

Whenever logs are reset, “Reset Logs dd-MMM-yyy hh:mm:ss” is recorded in the Event log.

If the logs are saved to a memory card, the machine’s serial number is saved along with the current contents of the logs and the date and time.

Error History ⏴

The Error History log lists the last 200 errors logged since the last log reset, starting with the most recent. The system stores the last 1,000 errors logged since the last log reset.

Event History ⏴

The Event History log records the service history of the device. This includes: service calibrations, entry into the service mode, options enabled, and software installation. In the event of a board replacement, it is understood that this log like all others could be lost.

The Event History menu lists the last 200 events logged starting with the most recent. The Event History log stores the last 1000 events.

The Event History log cannot be reset.

Alarm History ⏴

The Alarm History log lists the last 200 medium and high priority parameter alarms since the last log reset starting with the most recent. The Alarm History log store the last 1000 entries.

Copy Logs

The Copy Logs function copies Error, Event, and Alarm logs along with the software/hardware configuration to a text file on a PCMCIA card. The copying takes about one minute.

Note: Do not remove the Flash Card until the screen shows copy is complete.

4a.5 Calibration

For step-by-step instruction, refer to Section 5.4, "*Ventilator Calibrations*."

Menu Item	Message text
Instructions	
User Calibration	Show the normal user calibration menu.
Manifold P Span	Calibrate manifold pressure transducer.
Insp Flow Zero	Zero inspiratory flow valve.
Insp Flow Valve	Calibrate inspiratory flow valve.
Bleed Resistor	Calibrate bleed resister flow.
Paw Span	Calibrate the airway pressure transducer.
Zero Gas Xducrs	Calibrate the gas supply transducers.
Cal Config	Set vent drive gas and altitude.
Previous Menu	Return to previous menu.

4a.5.1 User Calibration menu

Menu Item	Message text
Flow and Pressure	Calibrate the flow and pressure sensors.
Circuit O2 Cell	Calibrate Circuit O2 Cell.
Airway Gas	Start Gas Calibration. Calibrate CO2, O2, N2O, and agent measurements.
Backlight Test	Push ComWheel to test back lights. Test every month.
Previous Menu	Return to the previous menu.

4a.5.2 Manifold P Span

The Manifold P Span instructions appear when the focus is on Manifold P Span menu item.

Refer to Section 5.4.2, "*Manifold P Span*."

Instructions

Read all steps before you start:

1. Remove the breathing system, the exhalation valve, and the metal plate.
2. Put #2 plugs in the manifold and the drive gas ports of the vent engine.
3. Connect a pressure gauge in line with the manifold pressure transducer.
4. Push the ComWheel to continue.
5. Select Start Manifold P Span.
6. Increase the Flow valve setting until the gauge shows 100 cmH2O.
7. When the gauge shows 100 cmH2O, select Save Calibration.

Manifold P Span menu

Menu Item	**Message text**	**Values/ Comments**
Insp Flow Valve (DAC)	Increase setting until test gauge shows 100 cmH2O (approx 1020 counts). Then save calibration.	0 to 4095 Disabled until user selects Start Manifold P Span.
Start Manifold P Span	Start Calibration. Increase flow valve setting until test gauge = 100 cmH2O (approximately 1020 counts). Then save calibration. Blocking message: "Connect a supply of the drive gas to continue."	Blocked when the ventilator drive gas supply pressure would cause a gas supply failure alarm during normal operation.
Save calibration	Save Manifold P Span calibration.	
Previous Menu	Return to the previous menu. During calibration: "Calibration in progress. Push ComWheel to cancel."	

4a.5.3 Insp Flow Zero

The Insp Flow Zero instructions appear when the focus is on the Insp Flow Zero menu item.

Refer to Section 5.4.4, “*Insp Flow Zero*.”

Instructions

Read all steps before you start:
1. Push the ComWheel to start the zero check
2. No disassembly is required.

- If the outcome of the calibration is Pass, the new calibration data is saved.
- If the outcome is Fail, the old calibration data is retained.
- The result of the calibration is saved to the Event Log.

Selecting Previous Menu before the calibration is done aborts the calibration in progress and keeps the old calibration constants.

Insp Flow Zero menu

Menu Item	Message text	Values
Start	If the result is failed, do the insp flow valve calibration.	Pass or Fail
Previous Menu	Return to previous menu. During Calibration: “Calibration in progress. Push ComWheel to cancel.”	

4a.5.4 Inspiratory Flow Valve

The Inspiratory Flow Valve instructions appear when the focus is on the Insp Flow Valve menu item.

Refer to Section 5.4.3, "*Inspiratory Flow Valve Cal*."

Instructions

Read all steps before you start:
1. Complete the Manifold P Span calibration.
2. Put #2 plugs in the manifold and the drive gas ports of the vent engine.
3. Push the ComWheel to show the next menu.
4. Select Stage 1 calibration.
5. After Pass, replace the manifold port plug with the calibration orifice.
6. Select Stage 2 calibration.
7. You MUST do both stages for the calibration to be saved.

During calibration, a separate menu shows the counts and corresponding flow at each step.

- If the outcome of both stages of the calibration is Pass, the new calibration data is saved.
- If the outcome of either stage is Fail, the old calibration data is retained.
- The results of each stage of the calibration are saved to the Event Log.

Selecting Previous Menu before the calibration is done, aborts the calibration in progress and keep the old calibration constants.

Insp Flow Valve Menu

Menu Item	Message text	Comments
Stage 1	Calibrate the insp flow valve at low flows. Blocked text: “Connect a supply of the drive gas to continue.”	Blocked if the ventilator drive gas supply pressure would cause a gas supply alarm during normal operation.
Stage 2	Calibrate the insp flow valve at high flows. Blocked text: “Stage 1 calibration is required first.”	Blocked if Stage 1 has not been completed.
Insp Flow Valve Data	Show insp flow valve calibration table.	
Previous Menu	Return to previous menu. During Calibration: “Calibration in progress. Push ComWheel to cancel.”	

Insp Flow Valve Data menu

The Insp Flow Valve Data menu contains a table of 24 entries from the previous calibration. The table is erased at the start of Stage 1. The table is updated in real time during the calibration.

4a.5.5 Bleed Resistor

The Bleed Resistor instructions appear when the focus is on the Bleed Resistor menu item.

Refer to Section 5.4.5, "*Bleed Resistor Cal*."

Instructions

Read all steps before you start:
1. Complete the Insp Flow Valve calibration.
2. Put #2 plugs in the manifold and the drive gas ports of the vent engine.
3. Push the ComWheel to show the next menu.
4. Select Start.

The calibration fails if the flow required to reach 91 cmH2O is > 16 l/min.

- If the outcome of the calibration is Pass, the new calibration data is saved.
- If the outcome is Fail, the old calibration data is retained.
- The result of the calibration is saved to the Event Log.

Selecting Previous Menu before the calibration is done aborts the calibration in progress and keep the old calibration constants.

Bleed Resistor Menu

Menu Item	Message text	Comments
Start	Calibrate manifold pressure to bleed resistor flow. Blocked text: "Connect a supply of the drive gas to continue."	Blocked if the ventilator drive gas supply pressure would cause a gas supply failure alarm during normal operation.
Bleed Resistor Data	Show bleed resistor calibration table.	
Previous Menu	Return to the previous menu. During Calibration: "Calibration in progress. Push ComWheel to cancel."	

Bleed Resistor Data menu

The Bleed Resistor Data menu contains a table of 17 entries from a previous calibration. The table is erased at the start of the calibration. The table is updated in real time during the calibration.

4a.5.6 Paw Span

The Airway P Span instructions appear when the focus is on Paw Span menu item.

Refer to Section 5.4.6, "*Paw Span*."

Instructions

Read all steps before you start:

1. Complete the Bleed Resistor calibration.
2. Install the flow sensor and circuit module
3. Put a #2 plug in the drive gas port of the vent engine.
4. Put the calibrated orifice in the manifold port of the vent engine.
5. Connect the pressure tee to the insp port. Connect the tee to the calibrated orifice with a 22 mm tube.
6. Connect a pressure gauge to the pressure tee.
7. Select Start Paw Span.
8. Increase the flow valve setting until the gauge shows 100 cmH2O.
9. Select Save Calibration

Paw Span menu

Menu Item	Message text	Values/Comments
Insp Flow Valve (DAC)	Increase setting until test gauge shows 100 cmH2O (approximately 1020 counts). Then save calibration.	0 to 4095 (initially set to 800)
Start Paw Span	Start Calibration. Increase flow valve setting until test gauge = 100 cmH2O (approximately 1020 counts). Then save calibration. Blocked text: Connect a supply of the drive gas to continue.	Blocked if the ventilator drive gas supply pressure would cause a gas supply failure alarm during normal operation.
Save calibration	Save Paw Span calibration.	Saves new calibration data. Writes calibration result, date and time to the event log.
Previous Menu	Return to the previous menu. During Calibration: "Calibration in progress. Push ComWheel to cancel."	

4a.5.7 Zero Gas Xducrs

The Zero Gas Xducrs instructions appear when the focus is on the Zero Gas Xducer menu item.

Instructions

Read all steps before you start:
1. Remove all cylinders.
2. Disconnect all pipeline supplies.
3. Select Zero Gas Xducers.
4. Select Start Zero on the next menu.
This page also shows:
• Gas supply pressures
• Gas supply ID

A failed test is usually the result of a pipeline or cylinder still connected to the system.

- If the outcome of the calibration is Pass, the new calibration data is saved.
- If the outcome is Fail, the old calibration data is retained.
- The result of the calibration is saved to the Event Log.

Selecting Previous Menu before the calibration is done aborts the calibration in progress and keep the old calibration constants.

Zero Gas Xducrs menu

The Zero Gas Xducrs menu shows only transducers that are installed. If not installed, the menu row is blank.

Menu Item	Message text	Values
O2 Pipeline		0-4095 Counts
O2 Cylinder 1		0-4095 Counts
O2 Cylinder 2		0-4095 Counts
N2O Pipeline		0-4095 Counts
N2O Cylinder		0-4095 Counts
Air Pipeline		0-4095 Counts
Air Cylinder		0-4095 Counts
Start Zero	Disconnect all pipelines and remove cylinders. Then select Start Zero.	
Previous Menu	Return to the previous menu. During Calibration: “Calibration in progress. Push ComWheel to cancel.”	

4a.5.8 Cal Config

Before calibration, you must verify that the Ventilator Drive Gas and the Altitude settings are set appropriately to match the current drive gas configuration and machine location.

If you change any of the settings in the Cal Config menu, you must restart the system.

Cal Config menu

Menu Item	Message text	Values
Ventilator Drive Gas	Change drive gas to match machine configuration.	Air, O2
Altitude	Change altitude used for gas calculations.	–400 to 3000 m (in 100-m increments)

4a.5.9 Mixer P Zero

(for System software 3.X; previous versions do not include this functiin)

The Mixer P Zero instructions appear on the Mixer P Zero menu.

Instructions

Back	Default	Start

To go back to factory defaults, select Defaults (above).

To Zero Pres Sensors:

1. Disconnect pipeline gas supplies.
2. Close the gas cylinders.
3. Remove the flow sensors.
4. Insert a non-Des cassette.
5. Push the O2 Flush button for 3 seconds.
6. Let the system sit WITHOUT gas flow for > 5 min.
7. Select Start.

Do not disturb the system while waiting for results.

Note

If repeated zero attempts fail, follow the procedure below:

1. Gain access to the components in the pan electrical enclosure (Section 9.9).
2. Disconnect the Alt O2 inlet tubing elbow fitting from the Mixer manifold.
3. Disconnect the tubing from the outlet elbow fitting.
4. Repeat the Mixer P Zero following the instructions as they appear on the screen.
5. Reassemble in reverse order.

Notes

4b Install/Service Menus (HPDU)

In this section

4b.1 Service and Installation menu structure

This section describes the Service level functions that are part of the main software installed in the anesthesia machine.

Section 8a, “*Service Diagnostics and Software Download (DU)*,” covers the functions of the Compact Flash card used to download system software.

Section 12, “*Service Application*,” covers a separate, Windows based service application used to run service diagnostics and other service tests.

Menu structure

The Service menu structure has three levels which are password protected:

- Install/Service (super-user)
- Installation
- Service

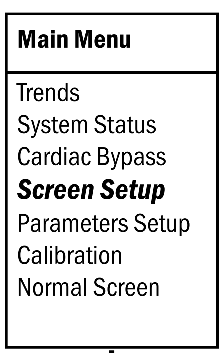
The **Install/Service** level (super-user password) supports standard hospital preferences: choosing units; setting ventilator, alarm, and gas delivery defaults.

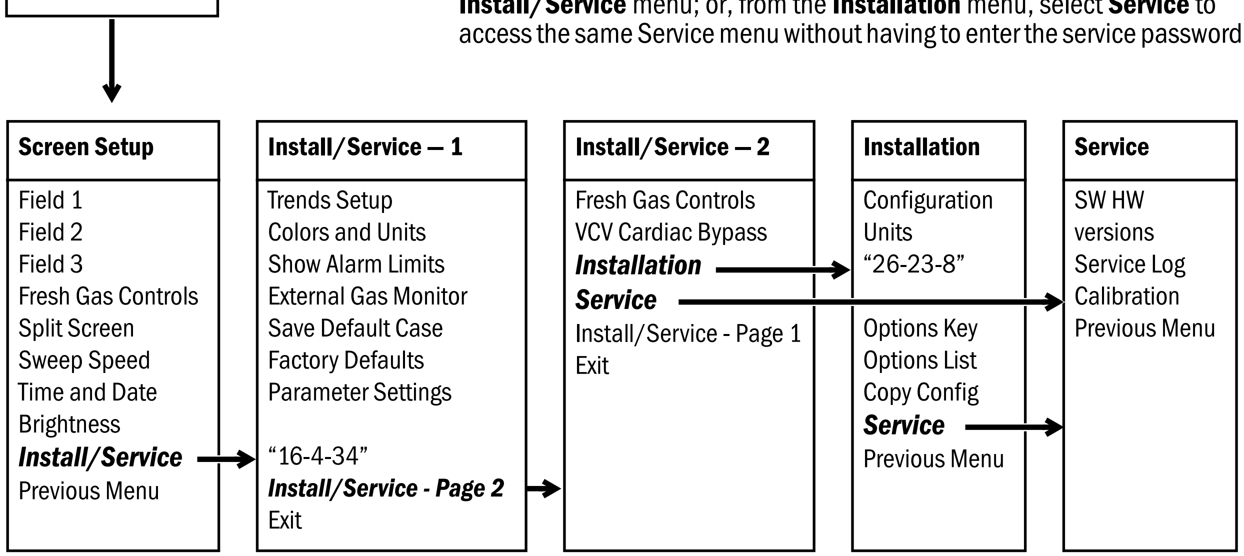
The **Installation** level requires the service password and supports language, gas color codes, flow tube position, country, hardware flags for system components (acgo or scgo etc.), enabling software options, and cloning a system.

The **Service** level requires the service password and supports diagnostic tools and automated component tests.

Follow the menu structure to access the various service screens:

- on the **Main Menu**, select **Screen Setup**;
- on the **Screen Setup** menu, select **Install/Service** to access the Install/Service (with super-user password) menu;
- on the **Install/Service** menu, select **Installation** (with service password) to access the Installation menu.
- to access the Service menu, select **Service** (with service password) on the **Install/Service** menu; or, from the **Installation** menu, select **Service** to access the same Service menu without having to enter the service password.





4b.2 Install/Service Menu (Super User)

Use the super-user password to access the Install/Service menu: “16-4-34.”

4b.2.1 Install/Service - Page 1

Menu Item	Message text	Comments
Trends Setup	Configure graphical trend pages.	
Colors and Units	Set colors and units of parameters.	Refer to section
Show Alarm Limits	Select yes to show alarm limits in digit fields.	Default is Yes.
External Gas Monitor	Yes disables O2 limit alarms, the “No O2 sensor alarm”, and the “No CO2 or AA monitor” alarm.	Default is No. Select yes only if system is using external monitor for O2, AA, and CO2.
Save Default Case	Save normal screen, gas settings, circuit type, ventilator, and alarm settings from the last case or presettings as defaults.	Last used alarm settings (including hide/show alarm limits, Auto MV Limit, alarm volume), screen layout (middle waveform selection, sweep speed), ventilator mode and setting, balance gas, and start case gas outlet selection are saved as facility defaults. **Note:** The Pmax alarm limit shall not be saved higher than 40 cmH2O. The low FiO2 alarm limit shall not be saved lower than 21%.
Factory Defaults	Return to default factory settings. After selecting Factory Defaults: “Reset machine for defaults to take effect.”	Action: All facility defaults get replaced with factory defaults. Super User settings also get set to Factory Defaults. No Service level configuration settings are changed.
Parameter Settings	Set volume conditions and CO2 humidity compensation.	
Install/Service - Page 2	Show page 2 of the Install/Service Menu.	
Exit	Turn power off to exit the Install/Service menu.	

Trends Setup

Menu Item	Message text	Values
Default Trend	Change default trend type: graphical, numerical, or settings.	Num (default), Graph, or Set
Graphical Trends	Configure graphical trend pages.	
Previous Menu	Return to previous menu.	

Graphical Trends

Menu Item	Message text	Values
Page 1 (Page 2 to Page 5)	Configure first graphical trend page (second, third, fourth, fifth)	
Previous Menu	Return to previous menu.	

Page Menus

<table>
<tr><th>Menu Item</th><th>Options</th><th>Page 1 Default</th><th>Page 2 Default</th><th>Page 3 Default</th><th>Page 4 Default</th><th>Page 5 Default</th></tr>
<tr><td>Field 1</td><td rowspan="4">Off—Select Off to clear trend field
rr+co2—respiration rate and CO2
Pres—Ppeak, Pplat, and PEEP
MVexp—expired minute volume and respiration rate
CO2—CO2
O2—O2
Bal—balance gas
AA1—current anesthetic
AA2—previous anesthetic agent if used
N2O—N2O
MAC—minimum alveolar concentration
TVexp—tidal volume and respiratory rate
Pmean—Pmean
Spont—spontaneous MVexp and respiration rate
Compl—compliance and Raw</td><td>Pres</td><td>O2</td><td>AA2</td><td>Bal</td><td>rr+CO2</td></tr>
<tr><td>Field 2</td><td>TVexp</td><td>N2O</td><td>N2O</td><td>MAC</td><td>Compl</td></tr>
<tr><td>Field 3</td><td>CO2</td><td>AA1</td><td>MAC</td><td>MVexp</td><td>Off</td></tr>
<tr><td></td><td colspan="5"></td></tr>
<tr><td>Previous Menu</td><td>Return to previous menu.</td><td colspan="5"></td></tr>
</table>

Colors and Units Menu

The Units menu can be accessed here in the super-user level to change individual preferences, or if required during installation, in the service level Installation menu.

Menu Item	**Message text**	**Values**
Colors	Set colors of parameters.	
Weight	Change weight unit: kg or lb.	kg or lb
CO2	Change CO2 unit: %, kPa, or mmHg.	%, kPa, or mmHg;
Gas Supply Pressure	Change gas supply pressure unit: kPa, psi, or bar.	psi, kPa, or bar
Paw	Change Paw unit: kPa, hPa, cmH2O, mmHg, mbar.	kPa, hPa, cmH2O, mmHg, or mbar
Previous Menu	Return to previous menu.	

Colors Menu

Menu Item	Message text	Values
Paw	Change color of Paw waveform, digits and trend.	Yellow, White, Green, Red, or Blue
Flow	Change color of Flow waveform, Flow and Volume digits and trends.	Yellow, White, Green, Red, or Blue
Resp	Change color of respiration, digits and trend.	Yellow, White, Green, Red, or Blue
CO2	Change color of CO2 waveform, digits and trend.	Yellow, White, Green, Red, or Blue
Previous Menu	Return to previous menu.	

Factory Defaults The following table lists the factory defaults for parameters. The table on the next page lists the factory defaults for alarm limits.

Factory defaults — Parameters

Parameter	Value
Vent Mode	VCV
TV (tidal volume)	500 ml
Pinsp	5 cmH2O (5 hPa, 0.5 kPa, 5 mbar, 4.0 mmHg)
RR	12 /min
Mech RR	12 /min
Tinsp	1.70
I:E	1:2.0
Trig. Window	25%
Flow Trig.	2 l/min
End Breath	30%
Psupport	2 cmH2O
Tpause	Off
Backup Time	30 s
Total Gas Flow	6 l/min with Circle and 10 l/min with Non-Circle
O2 Flow l/min	6 l/min with Circle and 10 l/min with Non-Circle
Control Style used for default setting	O2% when Install/Service Fresh Gas Controls menu item is set to "O2% or "User." Flow when Install/Service Fresh Gas Controls menu item is set to "Flow."
Balance Gas	Air
Circuit	Circle
Gas Outlet installed	SCGO
Paw Color	Yellow
Flow Color	Green
Resp Color	White
CO2 Color	White
Paw Units	cmH2O
Weight Units	kg
Temperature Units	C

Parameter	Value
CO2 Units	%
Altitude	300 m
Gas Supply Pressure Units	kPa
Decimal marker	. <dot>
Language	English
Gas Supply Colors	ISO (O2 = white, N2O = blue, Air = blk/wht)
O2 flow tube	Right side
Vent drive gas	O2
Rise Rate with Auto (PCV, SIMV/PSV, PSVPro, SIMV-PC Modes)	Auto
Rise Rate without Auto (PCV-VG Mode)	5
N2O enabled	No
Spirometry Source	Vent
Patient/Sensor Type	Adult
Auto MV Limit	Off
Alarm Volume	3
MV/TV Alarms	On
CO2 Audio	On
Sweep speed	Fast
Split screen	Gas
Wave field 1	Paw
Wave field 2	Flow
Wave field 3	CO2

Factory defaults — Alarm limits

Alarm Limit	Value
Pmax High	40 cmH2O (40 hPa, 4 kPa, 40 mbar, 30 mmHg)
MV High	10 l/min
MV Low	2 l/min
TV High	1000 ml
TV Low	Off
RR High	Off
RR Low	Off
Et CO2 High	8.0% (60 mmHg or 8.0 kPa)
Et CO2 Low	3.0% (23 mmHg or 2.0 kPa)
Fi CO2 High	Off
Fi O2High	Off
Fi O2 Low	21%
EtO2 High	Off
EtO2 Low	Off
Fi Iso High	5%
Fi Iso Low	Off
Et Iso High	Off
Et Iso Low	Off
Fi Sev High	8%
Fi Sev Low	Off
Et Sev High	Off
Et Sev Low	Off
Fi Des High	15%
Fi Des Low	Off
Et Des High	Off
Et Des Low	Off
Fi Enf High	5%
Fi Enf Low	Off
Et Enf High	Off
Et Enf Low	Off
Fi Hal High	5%
FI Hal Low	Off
Et Hal High	Off
Et Hal Low	Off

Parameter Settings

Menu Item	Message text	Values
TV Based on	Change volume calculation conditions: ATPD or BTPS.	ATPD - default (Ambient temperature and pressure, dry humidity condition) BTPS (Body temperature, ambient pressure, saturated humidity condition)
CO2 Numbers	Change humidity compensation type in CO2 partial pressure values.	Dry - default Wet
Previous Menu	Return to previous menu.	

4b.2.2 Install/Service - Page 2

Menu Item	Message text	Comments
Fresh Gas Controls	Select style for Fresh Gas Controls: O2% and Total Flow or Individual Gas Flows.	Default is O2%.
VCV Cardiac Bypass	Allow machine breaths during cardiac bypass.	Default is No.
Installation	Set language, gas colors, hardware, and install options.	Navigate with password to Installation menu. Password is “26-23-8”
Service	Show technical data for troubleshooting and calibration.	Navigate with password to Service menu. Password is “26-23-8”
Install/Service - Page 1	Show page 1 of the Install/Service Menu.	
Exit	Turn power off to exit the Install/Service menu.	

Fresh Gas Controls

Menu Item	Message text
User	Allow flow control styles to change between cases.
Flow	Select Individual Gas Flow controls.
O2%	Select O2% and Total Flow controls.

VCV Cardiac Bypass

Menu Item	Message text
No	Disable alveolar support in cardiac bypass.
Yes	Enable alveolar support in cardiac bypass.

4b.3 Installation Menu

Use the service-level password to access the Installation menu: "26-23-8."

Whenever the installation menu is entered, "Enter Service dd-mmm-yyyy hh:mm:ss" is recorded in the Event log.

Menu Item	Message text
Configuration	Set language, gas color code, O2 flowmeter position.
Units	Set units.
Options Key	Enable software options.
Options List	Display software options.
Copy Config	Normal Message "Save or install configuration and default settings using memory card." Blocked Message "Please insert memory card."
Service	Show error, event, and alarm logs. (Accessing the Service menu from the Installation menu does not require second use of service password.)
Previous Menu	Return to previous menu.

Configuration	Configuration Units	Options Key	Options List	Copy Configuration
Decimal Marker	Weight	Current Key	Available Options	Save to Card
Language	CO2	Entry 1	SIMV/PSV	Copy from Card
Gas supply Colors	Gas Supply Pressure	Entry 2	PCV	
O2 Flowtube	Paw	Entry 3	PSV Pro	
Ventilator Drive Gas		Entry 4	PCV-VG	
Altitude		Entry 5	VCV Cardiac Bypass	
Gas Outlet		Entry 6		
N2O Enabled		Entry 7		
		Save New Key		
		Control Board ID		

4b.3.1 Configuration

Menu Item	Message text	Values	Comments
Decimal Marker	Select decimal delineator.	0.01, 0 01 or 0,01	
Language	Change language translation of screen texts.	Chinese (simplified) Czech Danish Dutch English Finnish French German Greek Hungarian Italian Japanese Norwegian Polish Portuguese Russian Spanish Swedish Turkish	Default: English
Gas supply Colors	Change color of O2, N2O, and Air.	ANSI, ISO, Neutral	ANSI: O2 green, Air yellow, N2O blue; ISO: O2 white, Air black/white, N2O blue; Neutral: All gases white.
O2 Flowtube	O2 on left or right-hand side.	Left, Right	
Ventilator Drive Gas	Change drive gas to match machine configuration.	Air, O2	
Altitude	Change altitude used for gas calculations.	–400 to 3000 m in 100-m increments	
Gas Outlet*	Change type of fresh gas outlet.	SCGO, ACGO	SCGO: Use insp port. ACGO: Use auxiliary port.
N2O Enabled	Change to match machine configuration.	Yes; No	

* For machines without a separate auxiliary common gas outlet and selector switch, set ***Gas Outlet*** to SCGO: Selectable Common Gas Outlet.

* For machines with an external auxiliary common gas outlet and selector switch, set ***Gas Outlet*** to ACGO: Auxiliary Common Gas Outlet

4b.3.2 Configuration Units

This is the same menu that is accessible from the super-user Install/Service menu.

Menu Item	Message text	Values
Weight	Change weight unit: kg or lb.	kg or lb
CO2	Change CO2 unit: %, kPa, or mmHg.	%, kPa, or mmHg
Gas Supply Pressure	Change gas supply pressure unit: kPa, psi, or bar.	psi, kPa, bar
Paw	Change Paw unit: kPa, hPa, cmH2O, mmHg, mbar.	kPa, hPa, cmH2O, mmHg, or mbar

4b.3.3 Options Key

The Options Key menu is used to configure the software to include the features that the customer has purchased. The included features are shown in the Options List menu.

Options Key menu

Menu Item	Message text	Values
Current Key	Enter key code to enable options.	XXXAXBC
Entry 1	Enter first entry of key-code.	0 to 9, A to Z, ~, !, @, #, $, %, ^, *, (,), ?
Entry 2	Enter second entry of key-code.	
Entry 3	Enter third entry of key-code.	
Entry 4	Enter fourth entry of key-code.	
Entry 5	Enter fifth entry of key-code.	
Entry 6	Enter sixth entry of key-code.	
Entry 7	Enter seventh entry of key-code.	
Save New Key	Confirm entries for key-code.	
Control Board ID	Control number used by key-code.	XXX

When options are added, “Add <option> dd-MMM-yyy hh:mm:ss” is written to the event log.

If more than one option is added, each option is be listed separately.

Options List menu

The options list shows which options are enabled.

Menu Item	Message text	Values *
Available Options		
SIMV/PSV	SIMV vent w/pressure support.	On, Off
PCV	Pressure controlled ventilation.	On, Off
PSV Pro	Pressure support ventilation w/backup.	On, Off
PCV-VG	Pressure controlled volume guaranteed ventilation.	On, Off
VCV Cardiac Bypass	Allow VCV during cardiac bypass.	On, Off

* On if option enabled. Off if disabled.

4b.3.4 Copy Configuration

Copy Configuration menu

Menu Item	Message text	Values	Comments
Save to Card	Save Configuration and defaults to card.	<blank>, Fail, or OK. The field is blank until the data has either been written to the card (OK) or the system determines it cannot write to the card (Fail).	Saves all settings that are not hardware dependent, including facility defaults, colors, units, O2 flow tube position, decimal marker, and altitude.
Copy from Card	Copy Configuration and defaults from card. When completed: Copy from card complete. Please reboot system.	<blank>, Fail, or OK. The field is blank until the data has either been read from the card (OK) or the system determines it cannot read the card or the card does not have the required data (Fail).	

Systems cannot accept configuration files from a different product model.

The software version is stored with the saved configuration. A system will reject any configurations from other than the current version of software.

Selecting Save to Card overwrites any configuration on the card.

4b.4 Service Menu

Use the service-level password to access the Service menu: “26-23-8.”

Whenever service menu is entered, “Enter Service dd-mmm-yyyy hh:mm:ss” is recorded in the Event log.

Menu Item	Message text
SW HW versions	Scroll through system information.
Service Log	Show error, event, and alarm histories.
Calibration	Push ComWheel to perform service Calibrations.
Previous Menu	Return to previous menu.

SW HW Versions
Total Time: Software Release: Model Code: Machine Serial Number: Option Package: Option Code: Anes . . . . . Disp . . . . . Mixer . . . . . Vent . . . . . Power . . . . . MGas . . . . . EVap . . . . .

Service Log Menu
Scroll Recent Error History Event History Alarm History Copy Logs Reset Logs Previous Menu

Calibration
Instructions Spiro Calibration User Calibration Manifold P Span Insp Flow Valve Insp Flow Zero Bleed Resistor Paw Span Zero Gas Xducrs Cal Config Mixer P Zero Previous Menu

4b.4.1 Software/ Hardware Ver Menu

Turn the ComWheel to scroll through the list box.

Push the ComWheel to return to the Service menu.

System Information menu

List box text with X=Number, A, B, C = letter
Total Time: XXXXX (Minutes)
Software Release: XX.XX
Model Code: XXX
Machine Serial Number: ABCDXXXXX
Option Package: XXX
Options Code: XXXXX
Anes Software Version: XX.XX
Anes Hardware Version: XXXX-XXXX-XXX REV A
Anes Board Serial Number: ABCXXXXX
Disp Software Version: XX.XX
Disp BIOS Ver: XX.XX
Disp Hardware Version: XXXX-XXXX-XXX REV A
Disp Hardware Serial Number: ABCXXXXX
Mixer Software Version: XX.XX
Mixer Hardware Version: XXXX-XXXX-XXX REV A
Mixer Board Serial Number: ABCXXXXX
Mixer O2 Flow Sensor Serial Number: XXXXXXXXX
Mixer Balance Gas Flow Sensor Serial Number: XXXXXXXXX
Vent Software Version: XX.XX
Vent Hardware Version: XXXX-XXXX-XXX REV A
Vent Intf Board Serial Number: ABCXXXXX
Power Software Version: XX.XX
Power Hardware Version: XXXX-XXXX-XXX REV A
Power Board Serial Number: ABCXXXXX
MGas Software Version: X.X
MGas Hardware Version: <module type>
MGas Hardware Serial Number: XXXXXXXX

The MGas information is only displayed when an Airway module is present.

4b.4.2 Service Log Menu

The Service log menu is an organized listing of stored events.

Menu Item	Message text
Scroll Recent	Scroll through newest entries.
Error History	Show error history.
Event History	Show event history.
Alarm History	Show alarm history.
Copy Logs	Save HW/SW info and all logs to memory card.
Reset Logs	Erase Error and Alarm log entries
Previous Menu	Return to previous menu.

Each history log shows at the top of the screen the total “Running Hours” and the date when the logs were last reset.

Whenever logs are reset, “Reset Logs dd-MMM-yyy hh:mm:ss” is recorded in the Event log.

If the logs are saved to a memory card, the machine’s serial number is saved along with the current contents of the logs and the date and time.

Error History ◂

The Error History log lists the last 200 errors logged since the last log reset, starting with the most recent. The system stores the last 1,000 errors logged since the last log reset.

Event History ◂

The Event History log records the service history of the device. This includes: service calibrations, entry into the service mode, options enabled, and software installation. In the event of a board replacement, it is understood that this log like all others could be lost.

The Event History menu lists the last 200 events logged starting with the most recent. The Event History log stores the last 1000 events.

The Event History log cannot be reset.

Alarm History ◂

The Alarm History log lists the last 200 medium and high priority parameter alarms since the last log reset starting with the most recent. The Alarm History log store the last 1000 entries.

Copy Logs

The Copy Logs function copies Error, Event, and Alarm logs along with the software/hardware configuration to a text file on a PCMCIA card. The copying takes about one minute.

Note: Do not remove the Flash Card until the screen shows copy is complete.

4b.5 Calibration

For step-by-step instruction, refer to Section 5.4, “*Ventilator Calibrations*.”

Menu Item	Message text
Instructions	These values are used for calibration: Ventilator drive gas - Air or O2 Altitude - XXXX m Change these values on the Cal Config menu.
Spiro Calibration	Check gas module spirometry gains. Blocking message: Insert gas module with spirometry
User Calibration	Show the normal user calibration menu.
Manifold P Span	Calibrate manifold pressure transducer.
Insp Flow Zero	Zero inspiratory flow valve.
Insp Flow Valve	Calibrate inspiratory flow valve.
Bleed Resistor	Calibrate bleed resister flow.
Paw Span	Calibrate the airway pressure transducer.
Zero Gas Xducrs	Calibrate the gas supply transducers.
Cal Config	Set vent drive gas and altitude.
Mixer P Zero	Zero mixer pres transducer.
Previous Menu	Return to previous menu.

4b.5.1 Spiro Calibration

The Spiro Calibration instructions appear when the focus is on Spiro Calibration menu item.

Instructions

To display TV data:
1. Connect a spirometry sensor to MGAS. 2. Push the ComWheel to continue. 3. Select the correct spirometry sensor type (Adult or Pedi). 4. Use the test device to deliver a known TV through the sensor. 5. If necessary, repeat steps 1-4 for the other type of sensor.

Spiro Calibration menu

Menu Item	Values	Comments
Sensor Type	Adult or Pedi	Select Sensor type: Adult (Dlite) or Pedi (Pedilite).
Insp Gain TVinsp	1000 _ _ _	 ml
Exp Gain TVexp	1000 _ _ _	 ml

4b.5.2 User Calibration menu

Menu Item	Message text
Flow and Pressure	Calibrate the flow and pressure sensors. Remove flow sensor module to start. Replace when Pass or Fail message appears.
Circuit O2 Cell	Calibrate Circuit O2 Cell. **21% O2** Remove Flow Sensor Module. Expose O2 Cell to Room Air. Start 21% calibration. May take 3 min. **100% O2** 1. Reconnect flow sensor module. 2. Set Bag/Vent switch to Vent. 3. Select 100% O2.
Airway Gas	Start Gas Calibration. Calibrate CO2, O2, N2O, and agent measurements. (MGAS module must be installed). Gas calibration is not available during gas sampling warm-up and certain alarms.
Backlight Test	Push ComWheel to test back lights. Test every month. This test turns off one backlight to test the other light. Screen brightness may change during test.
Previous Menu	Return to the previous menu.

4b.5.3 Manifold P Span

The Manifold P Span instructions appear when the focus is on Manifold P Span menu item.

Refer to Section 5.4.2, "*Manifold P Span*."

Instructions

Read all steps before you start:

1. Remove the breathing system, the exhalation valve, and the metal plate.
2. Put #2 plugs in the manifold and the drive gas ports of the vent engine.
3. Connect a pressure gauge in line with the manifold pressure transducer.
4. Push the ComWheel to continue.
5. Select Start Manifold P Span.
6. Increase the Flow valve setting until the gauge shows 100 cmH2O.
7. When the gauge shows 100 cmH2O, select Save Calibration.

Manifold P Span menu

Menu Item	Message text	Values/ Comments
Insp Flow Valve (DAC)	Increase setting until test gauge shows 100 cmH2O (approx 1020 counts). Then save calibration.	0 to 4095 Disabled until user selects "Start Manifold P Span".
Start Manifold P Span	Start Calibration. Increase flow valve setting until test gauge = 100 cmH2O (approximately 1020 counts). Then save calibration. Blocking message: "Connect a supply of the drive gas to continue."	Blocked when the ventilator drive gas supply pressure would cause a gas supply failure alarm during normal operation.
Save calibration	Save Manifold P Span calibration.	
Previous Menu	Return to the previous menu. During calibration: "Calibration in progress. Push ComWheel to cancel."	

4b.5.4 Inspiratory Flow Valve

The Inspiratory Flow Valve instructions appear when the focus is on the Insp Flow Valve menu item.

Refer to Section 5.4.3, "*Inspiratory Flow Valve Cal*."

Instructions

Read all steps before you start:
1. Complete the Manifold P Span calibration.
2. Put #2 plugs in the manifold and the drive gas ports of the vent engine.
3. Push the ComWheel to show the next menu.
4. Select Stage 1 calibration.
5. After Pass, replace the manifold port plug with the calibration orifice.
6. Select Stage 2 calibration.
7. You MUST do both stages for the calibration to be saved.

During calibration, a separate menu shows the counts and corresponding flow at each step.

- If the outcome of both stages of the calibration is Pass, the new calibration data is saved.
- If the outcome of either stage is Fail, the old calibration data is retained.
- The results of each stage of the calibration are saved to the Event Log.

Selecting Previous Menu before the calibration is done, aborts the calibration in progress and keep the old calibration constants.

Insp Flow Valve Menu

Menu Item	Message text	Comments
Stage 1	Calibrate the insp flow valve at low flows. Blocked text: "Connect a supply of the drive gas to continue."	Blocked if the ventilator drive gas supply pressure would cause a gas supply alarm during normal operation.
Stage 2	Calibrate the insp flow valve at high flows. Blocked text: "Stage 1 calibration is required first."	Blocked if Stage 1 has not been completed.
Insp Flow Valve Data	Show insp flow valve calibration table.	
Previous Menu	Return to previous menu. During Calibration: "Calibration in progress. Push ComWheel to cancel."	

Insp Flow Valve Data menu

The Insp Flow Valve Data menu contains a table of 24 entries from the previous calibration. The table is erased at the start of Stage 1. The table is updated in real time during the calibration.

4b.5.5 Insp Flow Zero

The Insp Flow Zero instructions appear when the focus is on the Insp Flow Zero menu item.

Refer to Section 5.4.4, "*Insp Flow Zero*."

Instructions

Read all steps before you start:
1. Push the ComWheel to start the zero check
2. No disassembly is required.

- If the outcome of the calibration is Pass, the new calibration data is saved.
- If the outcome is Fail, the old calibration data is retained.
- The result of the calibration is saved to the Event Log.

Selecting Previous Menu before the calibration is done aborts the calibration in progress and keeps the old calibration constants.

Insp Flow Zero menu

Menu Item	Message text	Values
Start	If the result is failed, do the insp flow valve calibration.	Pass or Fail
Previous Menu	Return to previous menu. During Calibration: "Calibration in progress. Push ComWheel to cancel."	

4b.5.6 Bleed Resistor

The Bleed Resistor instructions appear when the focus is on the Bleed Resistor menu item.

Refer to Section 5.4.5, "*Bleed Resistor Cal*."

Instructions

Read all steps before you start:
1. Complete the Insp Flow Valve calibration.
2. Put #2 plugs in the manifold and the drive gas ports of the vent engine.
3. Push the ComWheel to show the next menu.
4. Select Start.

The calibration fails if the flow required to reach 91 cmH2O is > 16 l/min.

- If the outcome of the calibration is Pass, the new calibration data is saved.
- If the outcome is Fail, the old calibration data is retained.
- The result of the calibration is saved to the Event Log.

Selecting Previous Menu before the calibration is done aborts the calibration in progress and keep the old calibration constants.

Bleed Resistor Menu

Menu Item	**Message text**	**Comments**
Start	Calibrate manifold pressure to bleed resistor flow. Blocked text: "Connect a supply of the drive gas to continue."	Blocked if the ventilator drive gas supply pressure would cause a gas supply failure alarm during normal operation.
Bleed Resistor Data	Show bleed resistor calibration table.	
Previous Menu	Return to the previous menu. During Calibration: "Calibration in progress. Push ComWheel to cancel."	

Bleed Resistor Data menu

The Bleed Resistor Data menu contains a table of 17 entries from a previous calibration. The table is erased at the start of the calibration. The table is updated in real time during the calibration.

4b.5.7 Paw Span

The Airway P Span instructions appear when the focus is on Paw Span menu item.

Refer to Section 5.4.6, "*Paw Span*."

Instructions

Read all steps before you start:

1. Complete the Bleed Resistor calibration.
2. Install the flow sensor and circuit module
3. Put a #2 plug in the drive gas port of the vent engine.
4. Put the calibrated orifice in the manifold port of the vent engine.
5. Connect the pressure tee to the insp port. Connect the tee to the calibrated orifice with a 22 mm tube.
6. Connect a pressure gauge to the pressure tee.
7. Select Start Paw Span.
8. Increase the flow valve setting until the gauge shows 100 cmH2O.
9. Select Save Calibration

Paw Span menu

Menu Item	Message text	Values/Comments
Insp Flow Valve (DAC)	Increase setting until test gauge shows 100 cmH2O (approximately 1020 counts). Then save calibration.	0 to 4095 (initially set to 800) Disabled until user selects "Start Paw Span".
Start Paw Span	Start Calibration. Increase flow valve setting until test gauge = 100 cmH2O (approximately 1020 counts). Then save calibration. Blocked text: Connect a supply of the drive gas to continue.	Blocked if the ventilator drive gas supply pressure would cause a gas supply failure alarm during normal operation.
Save calibration	Save Paw Span calibration.	Saves new calibration data. Writes calibration result, date and time to the event log.
Previous Menu	Return to the previous menu. During Calibration: "Calibration in progress. Push ComWheel to cancel."	

4b.5.8 Zero Gas Xducrs

The Zero Gas Xducers instructions appear when the focus is on the Zero Gas Xducer menu item.

Instructions

Read all steps before you start:
1. Remove all cylinders.
2. Disconnect all pipeline supplies.
3. Select Zero Gas Xducrs.
4. Select Start Zero on the next menu.
This page also shows:
Gas supply counts
Gas supply ID

A failed test is usually the result of a pipeline or cylinder still connected to the system.

- If the outcome of the calibration is Pass, the new calibration data is saved.
- If the outcome is Fail, the old calibration data is retained.
- The result of the calibration is saved to the Event Log.

Selecting Previous Menu before the calibration is done aborts the calibration in progress and keep the old calibration constants.

Zero Gas Xducrs menu

The Zero Gas Xducrs menu shows only transducers that are installed.
If not installed, the menu row is blank.

Menu Item	Message text	Values
O2 Pipeline		0-4095 Counts
O2 Cylinder 1		0-4095 Counts
O2 Cylinder 2		0-4095 Counts
N2O Pipeline		0-4095 Counts
N2O Cylinder		0-4095 Counts
Air Pipeline		0-4095 Counts
Air Cylinder		0-4095 Counts
Start Zero	Disconnect all pipelines and remove cylinders. Then select Start Zero.	
Previous Menu	Return to the previous menu. During Calibration: “Calibration in progress. Push ComWheel to cancel.”	

4b.5.9 Cal Config

Before calibration, you must verify that the Ventilator Drive Gas and the Altitude settings are set appropriately to match the current drive gas configuration and machine location.

If you change any of the settings in the Cal Config menu, you must restart the system.

Cal Config menu

Menu Item	Message text	Values
Ventilator Drive Gas	Change drive gas to match machine configuration.	Air, O2
Altitude	Change altitude used for gas calculations.	–400 to 3000 m (in 100-m increments)

4b.5.10 Mixer P Zero

The Mixer P Zero instructions appear on the Mixer P Zero menu.

Instructions

Back **Default** **Start**

To go back to factory defaults, select Defaults (above).

To Zero Pres Sensors:

1. Disconnect pipeline gas supplies.
2. Close the gas cylinders.
3. Remove the flow sensors.
4. Insert a non-Des cassette.
5. Push the O2 Flush button for 3 seconds.
6. Let the system sit WITHOUT gas flow for > 5 min.
7. Select Start.

Do not disturb the system while waiting for results.

Note

If repeated zero attempts fail, follow the procedure below:

1. Gain access to the components in the pan electrical enclosure (Section 9.9).
2. Disconnect the Alt O2 inlet tubing elbow fitting from the Mixer manifold.
3. Disconnect the tubing from the outlet elbow fitting.
4. Repeat the Mixer P Zero following the instructions as they appear on the screen.
5. Reassemble in reverse order.

5 Calibration

⚠ **WARNING** After adjustments and calibration are completed, always perform the checkout procedure. Refer to Section 3 of this manual.

In this section

5.1 Primary Regulators

Follow the procedure in Section 5.1.1 to gain access to the regulators. Then, in Section 5.1.2, select the test that is appropriate for the regulator you are testing.

⚠ **WARNING** When testing/adjusting N_2O regulators, nitrous oxide flows through the system. Use a safe and approved procedure to collect and remove it.

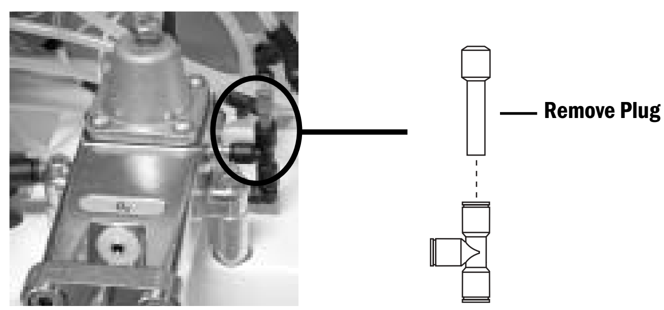
To test or calibrate the primary regulators, you must boot the system with the PCMCIA Service Application and access the Gas Diagnostics function as detailed in Section 8.

5.1.1 Test setup

⚠ WARNING Wear safety glasses while test device is connected to the test port.

⚠ CAUTION Be careful not to plug the output of the primary regulator without having a pressure relief valve in the output circuit.

1. Set the system switch to Standby.
2. Disconnect all pipeline supplies.
3. Remove the upper rear panel (Section 9.3).
4. If equipped, turn the auxiliary O_2 flowmeter control fully clockwise (no flow).
5. Install a full cylinder in the cylinder supply to be tested. It is essential that the cylinder be within 10% of its full pressure.
6. Remove the plug from the test port and connect a test device capable of measuring 689 kPa (100 psi).



5.1.2 Testing Primary Regulators

There are two variations of the test procedure for the primary regulators:

- Test A — For primary regulators that supply drive gas to the ventilator.
- Test B — For all gases not used to supply drive gas to the ventilator.

Test A **For primary regulators that supply drive gas to the ventilator (O_2 or Air):**

Under low flow conditions, the output pressure of a properly adjusted/ functioning regulator should fall within specifications listed in step 4e.

Under high flow conditions, the output pressure should not drop below the specifications listed in step 5g.

1. On the Main Menu of the Service Application, select ***Gas Diagnostics***.
2. On the Gas Diagnostics menu, select ***Gas Supplies***.
3. Slowly open the cylinder valve for the regulator being tested and observe the pressure reading for the cylinder.
4. **Low Flow Test:**
    a. On the Gas Diagnostics menu, set the flow of the tested gas to 0.5 l/min.
    b. On the Gas Diagnostics menu, select ***Gas Supplies***.
    c. Close the cylinder valve and allow the pressure to decay to 2068 kPa (300 psi) as indicated on the cylinder pressure display.
    d. At the time that the cylinder pressure reaches 2068 kPa (300 psi), select Main Menu on the Gas Diagnostics page to turn off gas flow.
    e. Within one minute, the test device reading must stabilize between:

       (60) DIN 372–400 kPa (54–58 psi)

       (50) Pin Indexed 310–341 kPa (45.0–49.5 psi).

       - If the test device pressure does not stabilize within one minute, replace the cylinder supply.
       - If the test device stabilizes within one minute, but the readings are not within specifications, readjust the regulator (Section 5.1.3).
5. **High Flow Test:**
    a. Slowly open the cylinder valve.
    b. Remove the ABS breathing system from the machine to allow continuous Insp Valve flow through the exhalation valve.
    c. On the Main Menu of the Service Application, select ***Vent Diagnostics***.
    d. On the Vent Diagnostics page, select ***Gas Inlet Vlv ON/OFF*** to Open the gas inlet valve.
       Press the ComWheel to return focus to the selection menu.
    e. Select ***Flow Valve Control***.

f. Adjust the Flow Valve counts until the ***Flow Valve Setting*** at the bottom of the screen reads 65 l/min.

g. While watching the test device, toggle the Gas Inlet Valve several times (Closed, Open, Closed):

- Press the ComWheel to return focus to the selection menu.
- Set Gas Inlet Vlv to Closed.
- Press the ComWheel to return focus to the selection menu.
- Set Gas Inlet Vlv to Open.
- Press the ComWheel to return focus to the selection menu.
- Set Gas Inlet Vlv to Closed.
- The minimum test device reading observed must be greater than:
  (60) DIN 221 kPa (32 psi)
  (50) Pin Indexed 207 kPa (30 psi)
- Repeat this step (4g) three times.

If the test device reading under “high flow” conditions is less than specified, readjust the regulator per the procedure in Section 5.1.3; however, set the regulated pressure higher by the difference you noted in this step plus 7 kPa (1 psi). This adjusts the “low flow” regulated output to the high side of the specification so that the “high flow” regulated pressure can fall within the specification.

If the regulator subsequently fails the “low flow” specification (step 3d) because the reading is too high, replace the cylinder supply.

6. Set the system switch to Standby.
7. Close the cylinder valve.
8. Bleed the system of all pressure.
9. Disconnect the test device and plug the test port (pull on the plug to ensure it is locked in the fitting).
10. Replace the ABS breathing system.
11. Replace the rear panel.
12. Perform the checkout procedure (Section 3).

Test B **For all gases not used to supply drive gas to the ventilator:**

Under low flow conditions, the output pressure of a properly adjusted/ functioning regulator should fall within specifications listed in step 4e.

Under high flow conditions, the output pressure should not drop below the specifications in step 5b.

1. On the Main Menu of the Service Application, select ***Gas Diagnostics***.
2. On the Gas Diagnostics menu, select ***Gas Supplies***.
3. Slowly open the cylinder valve for the regulator being tested and observe the pressure reading for the cylinder.
4. **Low Flow Test:**
   a. On the Gas Diagnostics menu, set the flow of the tested gas to 0.5 l/min.
   b. On the Gas Diagnostics menu, select ***Gas Supplies***.
   c. Close the cylinder valve and allow the pressure to decay to 2068 kPa (300 psi) as indicated on the cylinder pressure display.
   d. At the time that the cylinder pressure reaches 2068 kPa (300 psi), select Main Menu on the Gas Diagnostics page to turn off gas flow.
   e. Within one minute, the test device reading must stabilize between:

      (60) DIN 372–400 kPa (54–58 psi)

      (50) Pin Indexed 310–341 kPa (45.0–49.5 psi).

      - If the test device pressure does not stabilize within one minute, replace the cylinder supply.
      - If the test device stabilizes within one minute, but the readings are not within specifications, readjust the regulator (Section 5.1.3).
5. **High Flow Test:**
   a. On the Main Menu of the Service Application, select ***Gas Diagnostics***.
   b. On the Gas Diagnostics menu, set the flow of the tested gas to 10.0 l/min.

      The test device reading must be greater than:

      (60) DIN 221 kPa (32 psi)

      (50) Pin Indexed 221 kPa (32 psi)

      - If the test device reading under “high flow” conditions is less than specified, readjust the regulator per the procedure in Section 5.1.3; however, set the regulated pressure higher by the difference you noted in this step plus 7 kPa (1 psi). This adjusts the “low flow” regulated output to the high side of the specification so that the “high flow” regulated pressure can fall within the specification.
      - If the regulator subsequently fails the “low flow” specification (step 3b) because the reading is too high, replace the cylinder supply.

6. Set the system switch to Standby.
7. Close the cylinder valve.
8. Bleed the system of all pressure.
9. Disconnect the test device and plug the test port (pull on the plug to ensure it is locked in the fitting).
10. Replace the rear panel.
11. Perform the checkout procedure (Section 3).

5.1.3 Adjusting Primary Regulators

Important: Cylinder supplies in an S/5 Avance machine must have all primary regulators set to the same pressure range:
(50) Pin Indexed or (60) DIN.

If a regulator is replaced, the replacement regulator must be set (as required) to the same specification as the one removed.

Important: Install a full cylinder in the cylinder supply to be adjusted. It is essential that the cylinder be within 10% of its full pressure.

To adjust the primary regulators, follow the procedure in Section 5.1.1 to gain access to the regulators.

Do not attempt to adjust without flow.

1. On the Main Menu of the Service Application, select ***Gas Diagnostics***.
2. On the Gas Diagnostics menu, select ***Gas Supplies***.
3. Slowly open the cylinder valve for the regulator being tested and observe the pressure reading for the cylinder.

4. On the Gas Diagnostics menu, set the flow of the tested gas to 0.5 l/min.
5. On the Gas Diagnostics menu, select ***Gas Supplies***.
6. Close the cylinder valve and allow the pressure to decay to 2068 kPa (300 psi) as indicated on the cylinder pressure display.
7. When the cylinder gauge reaches 2068 kPa (300 psi), adjust the regulator output pressure to:

   (60) DIN 386–400 kPa (56–58 psi)

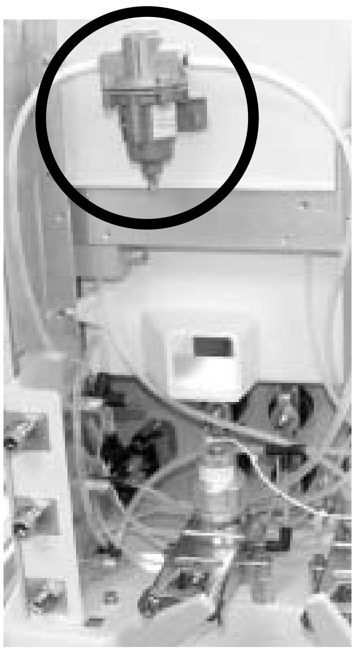
   (50) Pin Indexed 327–341 kPa (47.5–49.5 psi).

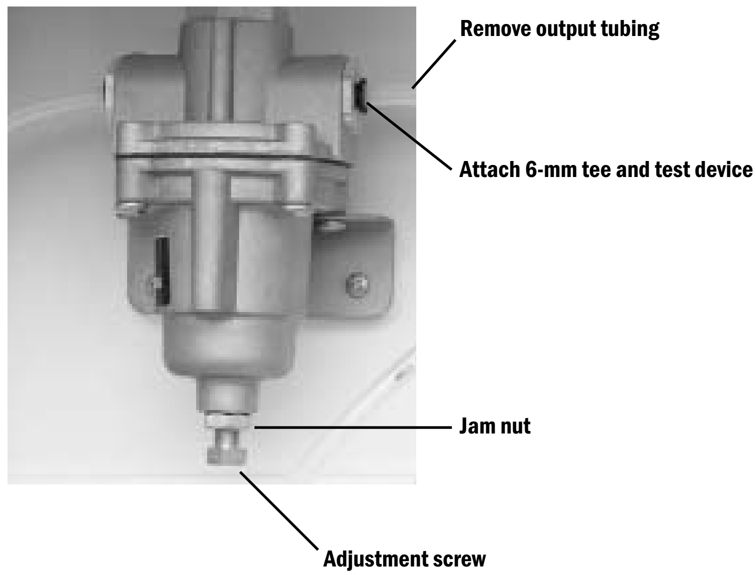
   Note: It may be necessary to open the cylinder valve and repeat steps 6 and 7 a number of times to achieve the above setting.

8. Test the regulator settings per the appropriate test in Section 5.1.2:
   - **Test A —** For primary regulators that supply drive gas to the ventilator.
   - **Test B —** For all gases not used to supply drive gas to the ventilator.

5.2 O_2 Flush Regulator

1. Bleed all gas pressure for the machine (Section 9.2).
2. Remove the upper rear panel (Section 9.3).
3. Remove the O_2 Flush Regulator output tubing. Attach a 6-mm tee and a test device to the open port.





4. Connect an O_2 pipeline supply or slowly open the O_2 cylinder valve.
5. Push the flush button just enough to achieve a slight flow or open the auxiliary flowmeter if equipped with this option. Read the pressure shown on the test device.

   The pressure should be 241 ±7 kPa (35 ±1.0 psi).
6. If adjustment is required:
   a. Loosen the adjustment screw's jam nut.
   b. Adjust the regulator (in small steps) to the above specification.
   c. Tighten the jam nut.
   d. Verify the reading.
7. Disconnect the pipeline supply or close the cylinder valve.
8. Bleed gas pressure by pushing the flush button; then, disconnect the tee and test device.
9. Reattach the output tubing to the regulator.
10. Install the rear panel.

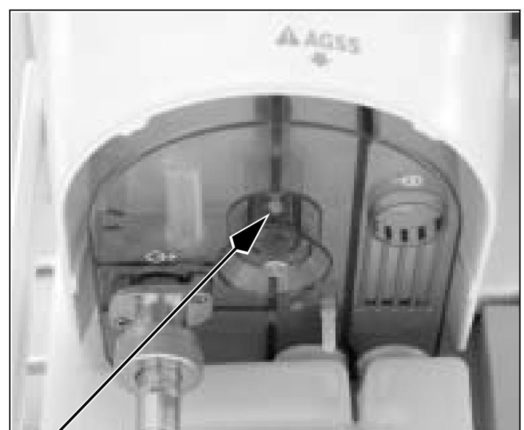
5.3 Adjust Drive Gas Regulator

The drive gas regulator must be adjusted while maintaining a flow of 15 l/min. To adjust the flow, you must boot the system with the PCMCIA Service Application and access the Vent Diagnostics function as detailed in Section 8.

The drive gas regulator should provide a constant gas input pressure of 172 kPa (25 psi).

Calibration setup

1. Attach a pressure test device to the regulator pressure port (shown below)
   - Remove the 6.35-mm (1/4 inch) plug.
   - Attach test device to the open port.
2. Remove the ABS breathing system from the machine to allow continuous Insp Valve flow through the exhalation valve.



Calibration procedure:

1. On the Main Menu of the Service Application, select ***Vent Diagnostics***.
2. On the Vent Diagnostics page, select ***Gas Inlet Vlv ON/OFF*** to Open the gas inlet valve.
   Press the ComWheel to return focus to the selection menu.
3. Select ***Flow Valve Control***.
4. Adjust the Flow Valve counts until the ***Flow Valve Setting*** at the bottom of the screen reads 15 l/min.
5. If required, adjust the regulator to 172 ±1.72 kPa (25 ±0.25 psi) through the access hole in the Vent Engine cover (Section 9.10.1).

5.4 Ventilator Calibrations

Before performing the ventilator calibrations, verify that the drive gas regulator is adjusted to specifications (Section 5.3).

The Service menu structure is detailed in Section 4. To access the Ventilator Calibrations menu:

1. Turn on the system.
2. Navigate the menu selections to the **Calibration** menu.
   - On the **Checkout** menu, select **Bypass Checks**.
   - On the **Start Case** menu, press the **Main Menu** button.
   - On the **Main Menu**, select **Screen Setup**.
   - On the **Screen Setup** menu, select **Install/Service** (dial in 16 - 4 - 34).
   - On the **Install/Service** menu, select **Service** (dial in 26 - 23 - 8).
   - On the **Service** menu, select **Calibration**.

Unless otherwise specified, perform the ventilator calibrations in the order that they appear on the Calibration menu.

- User Calibration
- Manifold P Span
- Insp Flow Zero
- Insp Flow Valve
- Bleed Resistor
- Paw Span

The following calibrations should be performed as required:

- Zero Gas Xducer:
  - The pipeline and cylinder pressure transducer should be “zeroed” at least once a year.
  - Whenever a pipeline or cylinder pressure transducer is replaced.
- Cal Config:
  - Reset the ***Ventilator Drive Gas*** to match the machine configuration.
  - Reset the ***Altitude*** whenever the machine is moved to a new location that differs by more than 100 meters.

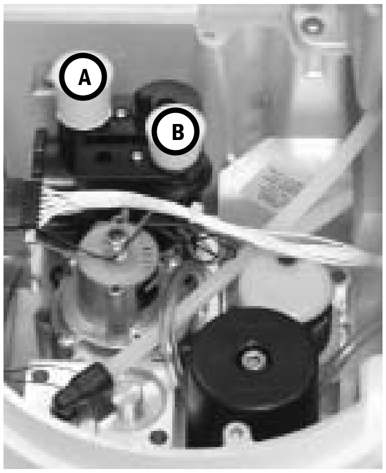
5.4.1 Cal Config

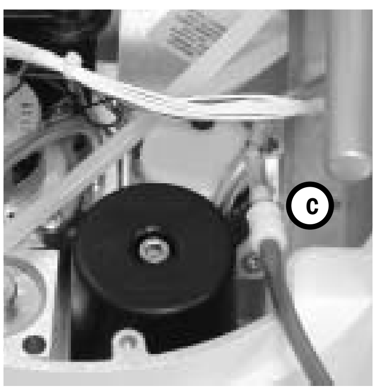
Before calibration, you must verify that the Ventilator Drive Gas and the Altitude settings are set appropriately to match the current drive gas configuration and machine location.

If you change any of the settings in the Cal Config menu, you must restart the system.

3. On the **Installation** menu, select **Configuration**.
4. On the **Configuration** menu, verify the **Ventilator Drive Gas** and the **Altitude** setting; adjust as necessary.
5. When done, reboot the system (System switch to Standby; then On).

5.4.2 Manifold P Span





Calibration setup:

1. Remove the ABS breathing system from the machine.
2. Remove the Exhalation Valve.
3. Remove the Vent Engine cover.
4. Plug the Drive Port (**A**) and the Manifold Port (**B**) on the Vent Engine interface valve.
5. Connect the manifold pressure tee adapter (**C**) — refer to Section 10.1.2 — to the Manifold Pressure Transducer tubing (white inline connectors).
6. Connect a manometer to the open port of the tee adapter.

Calibration procedure:

1. On the Calibration menu, select ***Manifold P Span***.
2. Select ***Start Manifold P Span***.
3. Adjust the Insp Flow Valve (DAC) setting until the manometer reading equals 100 cmH_2O:
   - start at approximately 950 counts (press the ComWheel to activate).
   - continue to increment the count until the manometer reading equals 100 cmH_2O.
4. Select ***Save Calibration***.
5. Select ***Previous Menu***.
6. Disconnect the manometer from the tee adapter.
7. Remove the tee adapter and reconnect the Manifold Pressure Transducer tubing.

Troubleshooting

Manifold P Span Calibration Failure

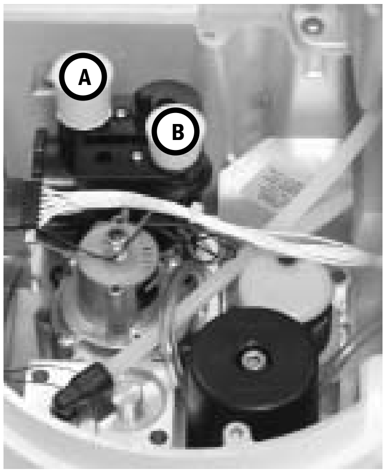
The Calibration will fail if the:

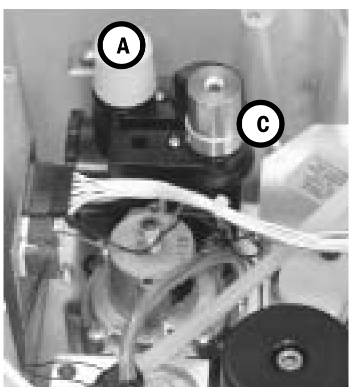
- ADC value calculated for span is outside the range of 21000-27000 counts.

Possible causes for calibration failure:

- Occlusion or moisture in bulkhead or tubing to VIB transducers.
- Pressure transducer outside of range limits – Check Service Application for A/D value.

5.4.3 Inspiratory Flow Valve Cal



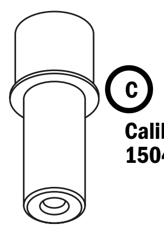


Calibration setup

Leave the Drive Port (**A**) and the Manifold Port (**B**) on the interface valve plugged.

Calibration procedure:

1. On the Calibration menu, select ***Insp Flow Valve***.
2. Push the ComWheel to enable the ***Stage 1*** calibration.
3. When Stage 1 is completed, remove the plug from the Manifold port and insert the calibrated orifice (**C**)
4. Push the ComWheel to enable the **Stage 2** calibration.
   (May take two minutes before you see any effects of the test on the screen.)
5. When Stage 2 is completed, select ***Previous Menu***.



Calibrated Flow Orifice
1504-3016-000

Troubleshooting

Stage 1 Calibration Failures

The Calibration will fail if the:

- Flow valve DAC counts are ≥ 1000 counts while finding points 2 through 6.
- Previously found DAC value is ≥ to the current DAC value while finding points 2 through 6.
- Previously recorded flow for a previous DAC is > the previous flow for a previous DAC.
- Points 2, 3, and 4 have the same value stored for flow (this would cause a divide by zero when extrapolating).

Possible causes for calibration failure:

- Check Altitude and Drive Gas selection
- Leaks around the test plugs
- Leaks in Vent Engine Interface Manifold – Inspect for leaks
- Insp Flow Valve not closing completely (leaky) – Replace Insp Flow Valve
- Drive gas regulator not adjusted / stable – Check regulator calibration
- Insp Flow Valve not linear – Replace Insp Flow Valve

Troubleshooting

Stage 2 Calibration Failures

The Calibration will fail if the:

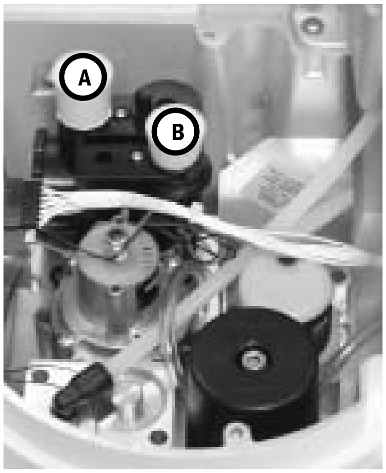
- Flow valve DAC reaches 4095 before determining the Lift-Off Point.
- Previously found DAC value is ≥ to the current DAC value while finding points 7 through 24.
- Previously recorded flow for a previous DAC is > the previous flow for a previous DAC.
- End point DAC of 4095 does not give a flow > 100 l/min.

Possible causes for calibration failure:

- Check Altitude and Drive Gas selection.
- Leaks around the test plug or Calibration Flow Orifice.
- Leaks in Vent Engine Interface Manifold – Inspect for leaks.
- Inadequate drive gas supply (cannot deliver > 100 l/min).
- Drive gas regulator not adjusted / stable – Check regulator calibration.
- Insp Flow Valve not linear – Replace Insp Flow Valve.

5.4.4 Insp Flow Zero

Calibration setup



1. Remove the Calibration Orifice from the Manifold port.
2. Plug the Manifold (**B**) port.
3. Leave the Drive Gas (**A**) port plugged.

Calibration procedure:

1. On the Calibration menu, select ***Insp Flow Zero***.
2. Select ***Start***.
3. Select ***Previous Menu***.

Troubleshooting

Insp Flow Zero Calibration Failures

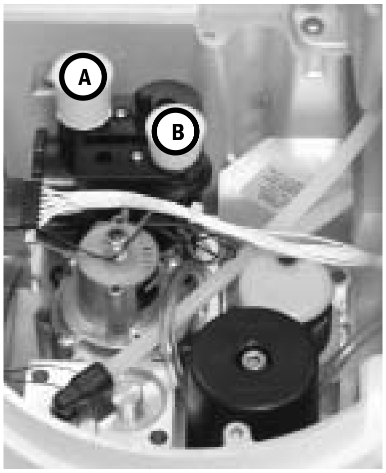
The Calibration will fail if the:

- Inspiratory Valve Calibration (stage 1 and stage 2) has not been performed.
- Corresponding flow is not between the 2nd and 5th point in the Inspiratory valve calibration table.

Possible causes for calibration failure:

- Inspiratory Valve Calibration not complete – Perform Calibration.
- Insp Flow Valve not closing completely (leaky) – Replace Insp Flow Valve.
- Insp Flow Valve not linear – Replace Insp Flow Valve.

5.4.5 Bleed Resistor Cal



Calibration setup

Leave the Drive Port (**A**) and the Manifold Port (**B**) on the interface valve plugged.

Calibration procedure

1. On the Calibration menu, select ***Bleed Resistor***.
2. Select ***Start***.
3. When the test is completed, select ***Previous Menu***.

Troubleshooting

Bleed Resistor Calibration Failures

The Calibration will fail if the:

- Flow is greater than 50 l/min before 105 cmH2O of pressure is reached.
- Table created has a pressure or flow that is greater than or equal to the next flow or pressure point in the table.

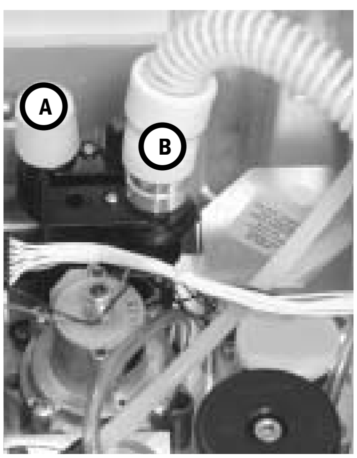
Possible causes for calibration failure:

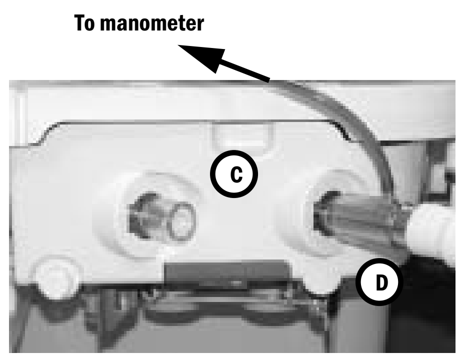
- Check Altitude and Drive Gas selection.
- Leaks around the test plugs.
- Drive gas regulator not adjusted / stable – Check regulator calibration.
- Inspiratory Valve Calibration not complete – Perform Calibration.
- Insp Flow Valve not closing completely (leaky) – Replace Insp Flow Valve.
- Insp Flow Valve not linear – Replace Insp Flow Valve.

5.4.6 Paw Span

Calibration setup

1. Leave the Drive port (**A**) port plugged.
2. Remove the plug from the Manifold port.
3. Attach a patient circuit tube to the Calibrated Flow Orifice.
4. Insert the Calibrated Flow Orifice into the Manifold port (**B**).
5. Separate the Circuit module from the ABS Bellows module.
6. Install only the Circuit module (**C**) on to the machine.
7. Connect a pressure sensing tee (**D**) to the inspiratory flow patient connection.
8. Connect the open end of the patient circuit tube to the flow port of the pressure sensing tee.
9. Connect a manometer to the pressure sensing port of the tee connector.





Calibration procedure

1. On the Calibration menu, select ***Paw Span***.
2. Select ***Start Paw Span***.
3. Adjust the Insp Flow Valve (DAC) setting until the manometer reading equals 100 cmH_2O:
   - start at approximately 950 counts (press the ComWheel to activate).
   - continue to increment the count until the manometer reading equals 100 cmH_2O.
4. Select ***Save Calibration***.
5. Select ***Previous Menu***.

Troubleshooting

Paw Span Calibration Failure

The Calibration will fail if the:

- ADC value calculated for span is outside the range of 21000-27000 counts.

Possible causes for calibration failure:

- Occlusion or moisture in bulkhead or tubing to VIB transducers.
- Pressure transducer outside of range limits – Check Service Application for A/D value.

Notes

6 Installation and Maintenance

In this section

This section covers the regular maintenance procedures (minimum requirements) needed to make sure that the S/5 Avance anesthesia machine operates to specifications.

⚠ WARNINGS

Do not perform testing or maintenance on the S/5 Avance anesthesia machine while it is being used on a patient. Possible injury can result.

Items can be contaminated due to infectious patients. Wear sterile rubber gloves. Contamination can spread to you and others.

Obey infection control and safety procedures. Used equipment may contain blood and body fluids.

6.1 Avance Installation Checklist

Serial Number:	Date: (YY/MM/DD) / /
Hospital:	Performed by:

☐ 1. Unpack and assemble the Avance System.

☐ 2. Reconfigure the sample gas return line as required (Section 9.26).

☐ 3. Access the Install/Service menu and configure the parameter colors as required (Section 4a.2.1).

☐ 4. Access the Installation menu from the Install/Service menu and change the following as required:

☐ a. Configuration (Section 4a.3.1)
- Decimal Marker
- Language
- Gas Supply Colors
- O_2 Flowtube
- Ventilator Drive Gas
- Altitude
- Gas Outlet
- N_2O Enabled

☐ b. Units Menu (Section 4a.3.2)
- Weight
- CO_2
- Gas Supply Pressure
- Paw

☐ c. Options List (Section 4a.3.3)
- Check that the factory installed ventilation options match the configuration purchased with the machine.

☐ d. Copy Configuration Menu (Section 4a.3.4)
- Can be used to save a configuration to a Compact Flash card and then copy the configuration to additional machines.

☐ e. From the Service Menu select the Service Log Menu (Section 4a.4.2)
- Review and reset the error and alarm log entries.

☐ f. From the Service Menu select Calibration and perform the following calibrations (Section 4a.5):
- User Calibration
- Manifold P Span
- Insp Flow Zero
- Insp Flow Valve
- Bleed Resistor
- Paw Span
- Zero Gas Xducers

☐ 5. Verify the "Schedule Service Calibration" message is not present in the normal display.

☐ 6. Complete the System Checkout by performing the following steps:

a. Inspect the system (Section 3.1)

b. System checkout (Section 3.4)

c. Pipeline and Cylinder tests (Section 3.8)

d. Flush Flow test (Section 3.10)

e. Alarm tests (Section 3.11)

f. Alternate O_2 flowmeter tests (Section 3.12)

g. Auxiliary O_2 flowmeter tests, if equipped with option (Section 3.13)

h. Integrated suction regulator tests, if equipped with option (Section 3.14)

i. Power failure test (Section 3.15)

j. Electrical safety tests (Section 3.16)

6.2 Avance Planned Maintenance

Serial Number:			Date: (YY/MM/DD) / /
Hospital:			Performed by:
☐ 12 months	☐ 24 month	☐ 48 month	☐ ______________

Every twelve (12) months

Perform the following steps every 12 months.
For details, refer to the sections listed.

- Sections marked URM are found in the User's Reference manuals for the Avance anesthesia system.
- Sections marked TRM are found in this Technical Reference manual.

Parts Replacement

☐ Replace the vaporizer port o-rings (Section 9.14.1)
(Kit Stock Number 1102-3016-000)

Checks and Tests

☐ 1. AGSS Maintenance (*URM - Part 2, Section 2*):
- Empty any condensate from the reservoir (disposable item).
- Inspect air brake for occlusion on active AGSS.
- Inspect, clean or replace filter on active AGSS.

☐ 2. Breathing System Maintenance (*URM - Part 2, Section 2*)

☐ 3. Bellows Assembly Maintenance (*URM - Part 2, Section 2*)

☐ 4. Bellows Assembly Tests (*URM - Part 2, Section 2*)

☐ 5. O_2 Cell Calibration (*URM - Part 2, Section 3*)

☐ 6. Flow Sensors Calibration (*URM - Part 1, Section 5*)

☐ 7. Perform the checkout procedures in Section 3.
- Inspect the system (*TRM - Section 3.1*)
- Backlight test (*TRM - Section 3.6*)
- Vaporizer back pressure test (*TRM - Section 3.7*)
- Pipeline and cylinder tests (*TRM - Section 3.8*)
- O_2 supply alarm test (*TRM - Section 3.8.1*)
- Pressure relief tests (*TRM - Section 3.9*)
- Flush Flow Test (*TRM - Section 3.10*)
- Alarm tests (*TRM - Section 3.11*)
- Power failure test (*TRM - Section 3.15*)

☐ 8. Alternate O_2 flowmeter tests (*TRM - Section 6.7*)

☐ 9. Auxiliary O_2 flowmeter tests (*TRM - Section 6.8*)

☐ 10. Integrated Suction Regulator tests (*TRM - Section 6.9*)

☐ 11. Mixer outlet check valve leak test (*TRM - Section 6.6.1*)

☐ 12. Zero the Mixer (*TRM - Section 8a.5.1*)

☐ 13. Mixer flow verification test (*TRM - Section 6.6.2*)

☐ 14. Perform the following diagnostics using the PCMCIA Service Application.

- Display Diagnostics (*TRM - Section 8a.4*).
- MOPV pressure relief valve test (*TRM - Section 6.4*).
- Pressure Limit Circuit test (*TRM - Section 6.5*).
- Adjust Drive Gas Regulator (*TRM - Section 5.3*).

☐ 15. From the Service Calibration menu (*TRM - Section 4a.5*), perform the following (refer to *TRM - Section 5.4* for details):

- User Cals
- Manifold P Span
- Inspiratory flow valve
- Inspiratory flow zero
- Bleed resistor
- Paw Span
- Zero Gas Transducers

☐ 16. From the Service Log menu (*TRM - Section 4a.4.2*), perform the following:

- Access the Error History log. If any error codes have been logged, follow the appropriate troubleshooting procedures. Clear the error log.

☐ 17. Perform the system "All Checks" (*TRM - Section 3.4*).

- Low P leak check (*TRM - Section 3.4.1*)
- Quick check (*TRM - Section 3.4.2*)
- Vent check (*TRM - Section 3.4.3*)
- Circuit O_2 cell check (*TRM - Section 3.4.4*)

☐ 18. Electrical safety tests (*TRM - Section 3.16*).

Every twenty-four (24) months

In addition to the 12-month requirements, replace the following parts every 24 months. All parts should be replaced before performing the checks, tests, and calibrations.

Parts Replacement

Refer to *TRM - Section 6.3*.

Perform the following step:

☐ 1. Replace the free breathing flapper valve (Stock Number 0211-1454-100).

☐ 2. Replace the free breathing valve o-ring (Stock Number 1503-3208-000).

Every forty-eight (48) months

In addition to the 24-month requirements, replace the following parts every 48 months. All parts should be replaced before performing the checks, tests, and calibrations.

Parts Replacement

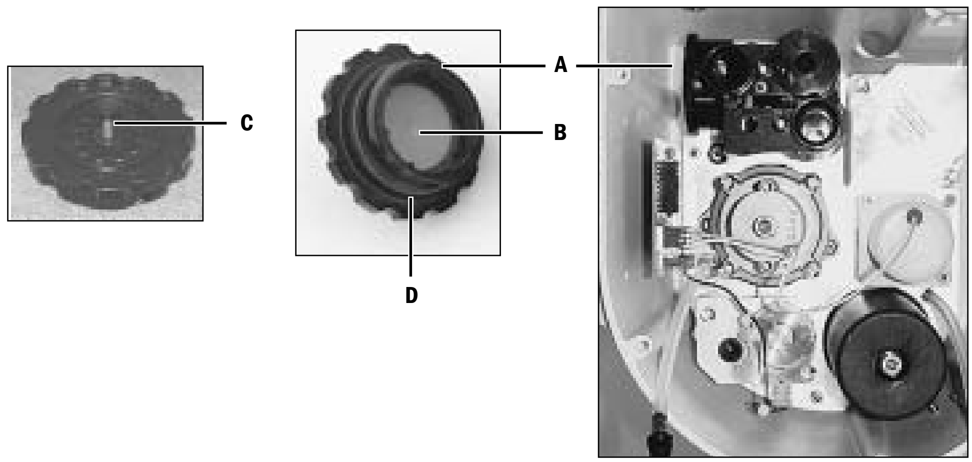
Refer to *TRM - Section 9.8.4*.

Perform the following step:

☐ 1. Replace the system batteries* (Stock Number 1009-5682-000).

*__Note__: Refer to the "*Battery capacity test*" in *TRM - Section 6.10*.

6.3 Free breathing valve maintenance



Refer to Section 9.10 to access the Pneumatic Vent Engine.

1. Unscrew the valve seat (**A**) from the side of the interface manifold.
2. Inspect the flapper (**B**) and valve seat for nicks, debris and cleanliness.

To replace the flapper valve

3. If necessary, clean the new flapper valve with alcohol.
4. Pull the tail (**C**) of the new free breathing valve flapper through the center of the valve seat until it locks in place.
5. Trim the tail flush with outside surface of the valve seat (refer to the removed flapper).
6. Replace the O-ring (**D**). Lubricate with a thin film of Krytox.
7. Hand screw the assembly into the interface manifold.
8. Reassemble the system.
9. Perform the Preoperative Checkout Procedure (refer to the User's Reference manual).

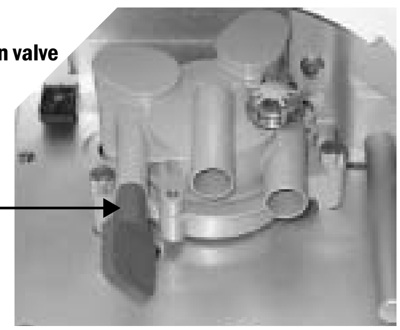
6.4 MOPV pressure relief valve test

⚠ **WARNING** Objects in the breathing system can stop gas flow to the patient. This can cause injury or death:

- Do not use a test plug that is small enough to fall into the breathing system.
- Make sure that there are no test plugs or other objects caught in the breathing system.

6.4.1 Test setup

1. Remove the ABS breathing system.
2. Plug the inspiratory flow (drive pressure) port of the exhalation valve with a stopper.



6.4.2 Test procedure

To test the pressure relief valve, you must establish a flow (blocked by setup above) of 30 l/min through the Inspiratory Flow Control valve. To adjust the flow, you must boot the system with the PCMCIA Service Application and access the Vent Diagnostics function as detailed in Section 8.

1. On the Main Menu of the Service Application, select ***Vent Diagnostics***.
2. On the Vent Diagnostics page, select ***Gas Inlet Vlv ON/OFF*** to Open the gas inlet valve.
   Press the ComWheel to return focus to the selection menu.
3. Select ***Flow Valve Control***.
4. Adjust the Flow Valve counts until the ***Flow Valve Setting*** at the bottom of the screen reads approximately 30 l/min.

3. Carefully listen for the MOPV relief weight to be relieving and “popping off” from its seat (a purring sound). This indicates the valve is functioning correctly.
4. Set the system switch to Standby.
5. Remove the stopper from the inspiratory flow port.
6. Reassemble the system.
7. Perform the Preoperative Checkout Procedure
   (refer to the User’s Reference manual).

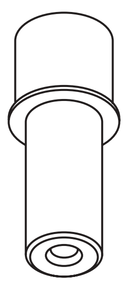
6.5 Pressure Limit Circuit test

To perform the test:

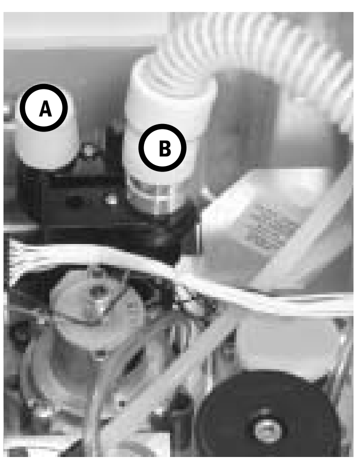
- establish a closed patient airway circuit.
- increment the pressure in the airway circuit.
- observe the output of the airway pressure transducer.
- note that the “pressure limit circuit” trips at approximately 109 cmH_2O.

Test setup

1. Remove the ABS breathing system from the machine.
2. Remove the Exhalation Valve.
3. Remove the Vent Engine cover.
4. Separate the Circuit Module from the ABS Bellows Module.
5. Install the Circuit Module only.
6. Plug the Drive Port (**A**) on the Vent Engine interface valve.
7. Attach a patient circuit tube to the Calibrated Flow Orifice test tool.
8. Insert the Calibrated Flow Orifice into the Manifold (pilot) Port (**B**).
9. Connect the open end of the patient circuit tube to the inspiratory flow patient connection (**C**).



Calibrated Flow Orifice
1504-3016-000

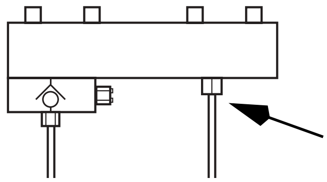


Test Procedure

1. On the Main Menu of the Service Application, select ***Vent Diagnostics***.
2. On the Vent Diagnostics menu, select ***Status*** and verify that “Over Pressure Circuit” reads OK.
3. Press the ComWheel to return focus to the selection menu.
4. Select ***Gas Inlet Vlv ON/OFF*** to Open the gas inlet valve.
   Press the ComWheel to return focus to the selection menu.
5. Select ***Flow Valve Control***.
6. Adjust the Flow Valve counts to approximately 1000 counts and observe the “Airway Pressure” reading.
7. Increase the flow count slowly until the “Airway Pressure” reading reaches approximately 109 cmH_2O.
8. Continue to increase the flow by one encoder click and observe the airway pressure until gas flow stops.
9. Select the Status page and verify that:
   - “Over Pressure Circuit” reads High Pressure.
   - “Gas Inlet Valve Feedback” reads Closed.

8. Reassemble the system.
9. Perform the Preoperative Checkout Procedure
   (refer to the User’s Reference manual).

6.6 Mixer test



To perform the mixer tests, you must gain access to the mixer outlet tubing which is connected to the inlet of the vaporizer manifold.

1. Remove the rear upper panel.
2. Disconnect the mixer outlet tube at the inlet to the vaporizer manifold.

6.6.1 Mixer outlet check valve leak test

To test the mixer outlet check valve you must apply back pressure to the check valve through the mixer outlet tubing and time the leak down rate of the pressure.

1. Tee in a pressure gauge and a syringe to the mixer outlet tube.
2. Slowly pressurize the mixer outlet check valve to 200 mmHg.
3. The pressure shown on the test gauge should not decrease by more than 10 mmHg in 30 seconds.

6.6.2 Mixer flow verification

To perform the flow verification test, you must attach a flowmeter to the mixer outlet tubing and access the Gas Diagnostics function of the Service Diagnostics application on the Software Download card.

1. Connect a flowmeter to mixer outlet tubing.
2. If the system includes an N_2O supply, connect the output of the flowmeter to the input of the vaporizer manifold to scavenge the flow.

Note: On machines with an HPDU and System Software 5.X, you can also set up gas flows on the Gas Delivery Schematic (Section 12.3.2) of the PC Service Application.

3. On the Gas Diagnostics menu
   - (Section 8a.2 for machines with a DU)
   - (Section 8b.5.1 for machines with an HPDU),

   select the following and verify the readings on the test flowmeter.

	Verify Flowmeter Reading	
Select	**Lower Limit (l/min)**	**Upper Limit (l/min)**
100% O2 at 10 l/min	9.0	11.0
100% O2 at 0.5 l/min	0.45	0.55
Air at 10 l/min	9.0	11.0
Air at 0.5 l/min	0.45	0.55
100% N2O at 10 l/min	9.0	11.0
100% N2O at 0.5 l/min	0.45	0.55

Note If you will be testing the Auxiliary O_2 flowmeter (Section 6.7), you can proceed to the Alternate O_2 "*Flow Accuracy Test*" at this point without reassembling the machine.

4. Remove the test device.
5. Connect the mixer outlet tubing to the vaporizer manifold.
6. Replace the back cover.
7. Perform the Preoperative Checkout Procedure
   (refer to the User's Reference manual).

6.7 Alternate O_2 flowmeter tests

1. Open the O_2 cylinder valve or connect an O_2 pipeline.
2. Rotate the Alt O_2 flow control fully clockwise to minimum flow.
3. Press the Alternate O_2 switch to turn on Alternate O_2 flow.
   The flowmeter should indicate 0.5 to 0.7 L/min.
4. Rotate the flow control counterclockwise (increase). The ball should rise immediately after rotation is begun. It should rise smoothly and steadily with continued counterclockwise rotation. When a desired flow is set, the ball should maintain in a steady position.
5. Rotate the flow control clockwise to minimum flow.
6. Press the Alternate O_2 switch to turn off Alternate O_2 flow; confirm yes.

Flow Accuracy Test

Note: To check flow accuracy, be sure that the flow test device is capable of measuring 0–15 l/min with an accuracy of ±2% of reading.

To perform the test, you must gain access to the mixer outlet tubing which is connected to the inlet of the vaporizer manifold.

1. Remove the rear cover.
2. Disconnect the mixer outlet tube at the inlet to the vaporizer manifold.
3. Connect a flowmeter to mixer outlet tubing.
4. Press the Alternate O_2 switch to turn on Alternate O_2 flow.
5. Adjust the flowmeter so the **center** of the ball aligns with the selected test point (observe that the ball maintains a steady position for 10 seconds).
6. The test device reading should be between the limits shown for each of the selected settings in the table below.

	Flow Tester Reading	
Flowmeter Setting L/min	**Lower Limit l/min**	**Upper Limit l/min**
minimum (valve fully closed)	0.5	0.7
1	0.5	1.5
3	2.5	3.5
5	4.5	5.5
10	9.0	11.0
maximum (valve fully open)	10.0	13.0

7. Rotate the flow control clockwise to minimum flow.
8. Close the O_2 cylinder valve or disconnect the O_2 pipeline.
9. Remove the test device.
10. Connect the mixer outlet tubing to the vaporizer manifold.
11. Replace the back cover.

10. Perform the Preoperative Checkout Procedure
    (refer to the User's Reference manual).

6.8 Auxiliary O_2 flowmeter tests

1. Open the O_2 cylinder valve or connect an O_2 pipeline.
2. Rotate the flow control clockwise (decrease) to shut off the flow. The ball should rest at the bottom of the flow tube and not move.
3. Rotate the flow control counterclockwise (increase). The ball should rise immediately after rotation is begun. It should rise smoothly and steadily with continued counterclockwise rotation. When a desired flow is set, the ball should maintain in a steady position.
4. Rotate the flow control clockwise to shut off the flow.

Flow Accuracy Test

Note: To check flow accuracy, be sure that the flow test device is capable of measuring 0 to 15 L/min with an accuracy of ±2% of reading.

1. Connect the flowmeter outlet to the flow test device.
2. Adjust the flowmeter so the **center** of the ball aligns with the selected test point (observe that the ball maintains a steady position for 10 seconds).
3. The test device reading should be between the limits shown for each of the selected settings in the table below.

	Flow Tester Reading	
Flowmeter Setting L/min	**Lower Limit L/min**	**Upper Limit L/min**
1	0.5	1.5
3	2.5	3.5
5	4.5	5.5
10	9.0	11.0
maximum (valve fully open)	12.0	-------

4. Rotate the flow control clockwise to shut off the flow.
5. Close the O_2 cylinder valve or disconnect the O_2 pipeline.

6.9 Integrated Suction Regulator tests

Note There are two types of integrated suction systems for the Avance anesthesia machine:

- Continuous Vacuum Regulator, Three-Mode, Pipeline Vacuum
- Continuous Vacuum Regulator, Three-Mode, Venturi Derived Vacuum

For Pipeline Vacuum systems,
a vacuum source of at least 500 mm Hg (67 kPa or 20 in Hg) is required for testing. The supply open flow must be a minimum of 50 L/min.

For Venturi Derived Vacuum systems,
an O_2 or Air source of at least 282 kPa (41 psi) is required for testing.

Gauge Accuracy The gauge needle should come to rest within the zero range bracket when no suction is being supplied. Gauges which do not comply may be out of tolerance.

Note To check gauge accuracy, be sure that the test gauge is capable of measuring 0 to 550 mm Hg with an accuracy of ±1% of reading.

1. Connect the suction patient port to the test gauge.
2. Turn the mode selector switch to I (ON).
3. Ensure that the vacuum test gauge is in agreement with the suction vacuum gauge ± 38 mm Hg/5 kPa at the following test points.

Test points

Suction vacuum gauge	**Test gauge tolerance**
100 mm Hg (13.3 kPa)	62–138 mm Hg (8.3–18.4 kPa)
300 mm Hg (40 kPa)	262–338 mm Hg (35–45 kPa)
500 mm Hg (66.7 kPa)	462-538 mm Hg (61.6–71.7) kPa)

Flow Test **Note:** To check flow accuracy, be sure that the flow test device is capable of measuring 0–30 L/min.

1. Connect the patient port of the suction regulator to the flow test device.
2. Rotate the suction control knob fully clockwise (increase).
3. Turn the mode selector switch to I (ON) and verify that the flow rate is:
    - at least 20 L/min.
4. Disconnect the test flowmeter.

(Tests continue on next page.)

Regulation Test

1. Turn the mode selector switch to I (ON).
2. Occlude the patient port of the suction regulator.
3. Set the vacuum regulator gauge to 100 mm Hg/13 kPa.
4. Open and close the patient port several times.
5. With the patient port occluded, the gauge should return to 100 mm Hg/13 kPa within a tolerance of ± 10 mm Hg/1.3 kPa.

Vacuum Bleed Test

1. Occlude the patient port of the suction regulator.
2. Set the vacuum regulator gauge to 100 mm Hg/13 kPa.
3. Turn the mode selector switch to O (OFF) and observe the gauge needle. It must return to the zero range bracket or stop pin within 10 seconds.

Vacuum Leak Test

1. Turn the mode selector switch to O (OFF).
2. Rotate the suction control knob a minimum of two full turns in the clockwise direction (increase suction) to ensure its setting is not at the off position.
3. Occlude the patient port of the suction regulator.
4. Observe the suction gauge, the needle should not move.
5. Rotate the suction control knob fully counterclockwise to ensure its setting is at the fully off position.
6. Turn the mode selector switch to I (ON).
7. Observe the suction gauge, the needle should not move.

6.10 Battery capacity test

Although replacement of the backup batteries is recommended at the end of 4 years, batteries that pass the capacity test can be considered viable for battery backup of the system for up to 6 years at the discretion of the hospital.

Before testing the batteries, ensure that they are fully charged.

Test procedure

1. Turn the system on and start a case (simulated).
2. Turn off the mains system breaker on the AC Inlet.
3. Allow the system to run on battery until it does an orderly shutdown and powers off (can be in excess of 90 minutes).
4. Set the system switch to Standby and turn on the mains system breaker.
5. Start up the system with the appropriate Software Download card and access Page 1 of the Power Controller Diagnostics function.

Note: On machines with an HPDU and System Software 5.X, you can also access the Power Board Diagnostics data (Section 12.7.1) with the PC Service Application.

DU (Section 8a.1.3)	HPDU (Section 8b.3.2)
Power Diagnostics Power Control	Special Functions Power Diagnostics Power Controller

6. Page 1 of the Power Control Power Diagnostics screen shows the "Date battery Tested" (the date of the last full discharge) and the "Last Full Discharge Time".
   - If the "Last Full Discharge Time" is greater than 45 minutes, the batteries can be left in service for one more year.
   - If the "Last Full Discharge Time" is less than 45 minutes, both batteries should be replaced.

Notes

7 Troubleshooting

In this section

7.1 Troubleshooting Guidelines

Review system error logs using the Special Functions feature of the Software Download card (Section 8a.5). Review the logs to identify issues and follow the appropriate subsystem troubleshooting procedures.

⚠ **WARNING** Objects in the breathing system can stop gas flow to the patient. This can cause injury or death:

- Do not use a test plug that is small enough to fall into the breathing system.
- Make sure that there are no test plugs or other objects caught in the breathing system.

7.2 Troubleshooting high pressure and low pressure leaks

Problem	Possible Cause	Action
High Pressure Leak	Pipeline leak	Use a leak detector or Snoop to check for source of leak. Repair or replace defective parts.
	O_2 flush valve	Use a leak detector or Snoop to check for source of leak. Make sure tubing connections are tight. Replace valve if defective.
	System switch	Use a leak detector or Snoop to check for source of leak. Make sure tubing connections are tight. Replace switch if defective.
	Cylinder not installed properly	Make sure cylinder is correctly aligned. Verify that tee handles are tight.
	Cylinder transducer	Use a leak detector or Snoop to check for source of leak. Tighten/replace transducer if defective.
	Cylinder gaskets	Use a leak detector or Snoop to check for source of leak. Replace gasket if defective.
	Relief valves	Use a leak detector or Snoop to check for source of leak. Replace valve if defective.

Problem	Possible Cause	Action
Low Pressure Leak (with vaporizer mounted)	Vaporizer not installed properly	Reseat vaporizer if not installed properly. Have vaporizer serviced at vaporizer center if vaporizer leaks.
	Missing or damaged o-ring on vaporizer manifold	Check condition of o-ring. Replace if missing or damaged.
	Loose fill port	Check fill port. Tighten if loose.
Low Pressure Leak (with or without vaporizer)	Leaking port valve on vaporizer manifold	Use the Vaporizer Manifold Valve Tester to check for leak. See Section 9.14.2 for instructions. If test fails, tighten, repair, or replace as needed.
	Leak in mixer	If vaporizer manifold passed previous tests: Remove tubing from inlet port of vaporizer manifold (mixer outlet tube) and perform leak test of mixer.
	Leaking relief valve on vaporizer manifold	Remove relief valve. Occlude opening. Perform leak test. If test passes, replace valve.
	Leaking flush valve	Attach pressure measuring device on CGO. Replace valve if device shows increased pressure.
	Leaking system switch	Attach pressure measuring device on CGO. Replace switch if device shows increased pressure.
Bellows leak	Pop-off valve diaphragm not sealing properly	Disassemble pop-off valve; inspect and clean seats; reseat; reassemble.
	Bellows mounting rim loose	Remove rim and pop-off valve diaphragm; reseat diaphragm; snap rim (2) into place.
	Bellows improperly mounted or has a hole or tear	Check that only the last bellows convolute is mounted to the rim and that the ring roll is in the groove under the rim. Inspect the bellows for damage; replace.
Breathing System Leak	Absorber canister open or missing	Install canister properly.
	Damaged/missing canister o-ring	Check/replace o-rings.
Breathing System Leak (Intermittent)	ACGO O_2 sense check valve	Replace.
Unable to begin mechanical ventilation	ABS not fully engaged	Remount ABS.
	No O_2 supply	Check O_2 supply.
	Defective Bag/Vent switch	Check Bag/Vent switch.

7.3 Troubleshooting Startup Screen (POST) messages – for DU

If the Avance system encounters a problem at startup to where it cannot initiate system software, a BIOS error message indicating the failure will be displayed.

Message	**What it indicates**	**Troubleshooting Action Required**
***NOTE: RTC failed. xx	This indicates an illegal value in the CPU's Real Time Clock date or time registers.	Set the system date and time manually to the correct values.
***NOTE: CMOS defaults reloaded.	This is an informational message.	No action needed.
***NOTE: CMOS battery failed. Replace soon.	Service is required to replace the CPU battery.	Replace the battery on the DU CPU board. Reload software and check out the system.
***NOTE: Alarm tone detection failed.	Service is required to correct a faulty connection to the speaker.	Reconnect the speaker if possible. Replace DU CPU board if speaker connection can not be corrected.
***NOTE: ECC failed. xx	The RAM memory ECC circuitry is faulty.	Replace the DU CPU board.
***NOTE: System reset. EC xx	This usually indicates a software (BIOS) failure.	Report this error, along with the machine logs, to Technical Support. Reload software. If problem persists, replace the DU CPU board.
***NOTE: Critical hardware failure. xx	Some of the DU hardware could not be initialized.	Replace the DU CPU board.
***NOTE: OS/App ROM CRC failed.	The software must be reloaded.	Reload software and check out the system.
***NOTE: System reset.	The software must be reloaded.	Reload Software and check out the system.

7.4 Troubleshooting Startup Screen (POST) messages — for HPDU

If the Avance system encounters a problem at startup to where it cannot initiate system software, a BIOS error message indicating the failure will be displayed.

Message	What it indicates	Troubleshooting Action Required
***ERROR: CPU data cache fault.	This indicates a hardware failure.	Replace the HPDU CPU board.
***ERROR: No bootable device available.	This indicates a problem with the internal CF card.	Check or replace the internal compact flash card.
***ERROR: Program load failed - CRC.	This usually indicates a software file corruption.	Reload the software and check out the system.
***ERROR: RAM memory error.	This indicates a hardware failure.	Replace the HPDU CPU board.
***ERROR: System reset: ECxx xx xx . . .	This usually indicates a software failure.	Report this error, along with the machine logs, to Technical Support. Reload software. If problem persists, replace the internal flash card and reload software. If problem persists, replace the HPDU CPU board.
***ERROR: System reset: FFFF FF FF	Indicates the HPDU lithium battery has lost contact with the holder or the battery is below voltage.	Replace the lithium battery if below rated voltage. Install the software downloader card to restore system setups.
***ERROR: watchdog circuit failed.	This indicates a hardware failure.	Replace the HPDU CPU board.
***NOTE: Alarm speaker not detected. Check connection.	Service is required to correct a faulty connection to the speaker.	Reconnect the speaker if possible. Replace the HPDU CPU board if speaker connection can not be corrected.
***NOTE: CMOS battery is weak. Please replace.	Service is required to replace the CPU battery.	Replace the battery on the HPDU CPU board. Reload software and check out the system.
***NOTE: RTC date/time error. Battery may be weak.	Service is required to replace the CPU battery.	Replace the battery on the HPDU CPU board. Reload software and check out the system.

7.5 Troubleshooting the HPDU Display

Symptom	Resolution
System will not boot from external Compact Flash card during software installation process	1. Verify that the Compact Flash card is properly inserted. 2. Insert a backup Compact Flash card. 3. Open the HPDU and verify that the external Compact Flash card carrier socket (1009-5961-000) is properly seated. 4. Replace external Compact Flash card carrier socket (1009-5961-000). 5. Replace HPDU main PCB.
Display appears mostly white and the green LED is on	1. Verify that the cable connecting the HPDU to the system's rear panel is properly seated. 2. Open the HPDU and verify that the cable connecting the main PCB to the display at J28 is properly seated within the mating housing and check for damage and/or wear. 3. Replace the HPDU.
Rotary encoder fails to work	1. Open the HPDU and verify that the cable connecting the main PCB to the rotary encoder at J38 is properly seated within the mating connector. 2. Verify that the revision of the flex cables connecting the main PCB to the keypads at J23 and J26 are at revision 101 or greater by inspecting the labels directly adhered to the flex cables. 3. Replace the rotary encoder, 4. Replace the HPDU main PCB.
Unit fails to boot and the green LED is on	1. Open the HPDU and ensure that the lithium coin cell at J17 on the main PCB is properly installed. 2. Replace the lithium coin cell at J17 on the main PCB. 3. Verify that the internal Flash card at J10 on the main PCB is properly seated. 4. Attempt to boot the system using a spare compact flash card and replace the card if necessary. 5. Attempt to boot the system from the external Compact Flash card. 6. Replace the HPDU main PCB.
Excessive fan noise	1. Clean the HPDU fan inlet filter. 2. Check for obstructions within the external fan and verify source of fan noise. 3. Open the HPDU and verify internal CPU fan noise. 4. Replace internal or external fan assembly if causing excessive noise.

7.6 Troubleshooting System Malfunction (safe-state) screen

Machine logs

- **Compatibility incomplete: No versions received from Vent SIB**
- **System Self-tests failed**

The above error log entries are due to the Ventilator failing its Power-On Self Test (Post).

When the ventilator fails its self-test, the system enters the safe-state.

The likely cause is a Gas Inlet Valve Solenoid that is not transitioning to the de-energized state when valve drive power is removed.

Troubleshooting above stated condition:

- Replace the Gas Inlet Valve Solenoid (Section 9.10.2).
- If problem continues, replace the Gas Inlet Valve components (Section 9.10.3).

7.7 Breathing System Leak Test Guide

Note Always do the ***System "All Checks"*** (Section 3.4) on the machine before proceeding with these breathing system leak tests.

- The ***Low P leak check*** looks for leaks between the mixer, vaporizer, and the inspiratory side of the breathing circuit.
- A failure in ***Quick check*** indicates a leak in Bag Mode.
- A failure in ***Vent check*** indicates a leak in Vent Mode.

Follow the troubleshooting flowcharts in Section 2.7.2 to determine the best sequence of tests for locating a breathing system leak.

The procedures in Section 7.7.3 test specific components of the breathing system for leaks.

⚠ **WARNING** Objects in the breathing system can stop gas flow to the patient. This can cause injury or death:

- Do not use a test plug that is small enough to fall into the breathing system.
- Make sure that there are no test plugs or other objects caught in the breathing system.

7.7.1 Check Valves

Make sure that the check valves on the breathing circuit module work correctly: The Inspiratory check valve rises during inspiration and falls at the start of expiration. The Expiratory check valve rises during expiration and falls at the start of inspiration. A leak across one of the check valves may be great enough to cause a "reverse flow" alarm.

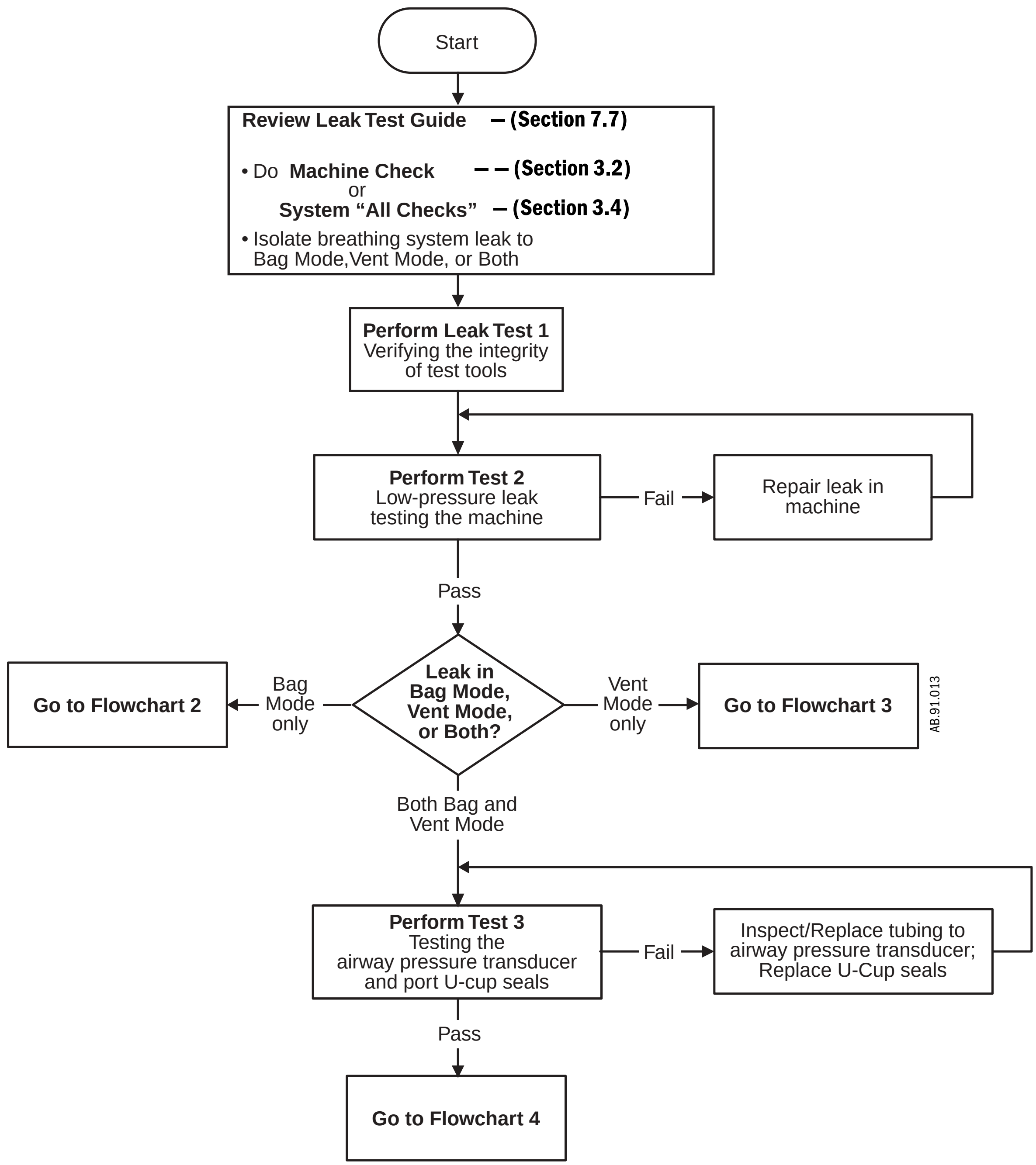
Inspiratory check valve

1. Set the system switch to On.
2. Set fresh gas flow to minimum.
3. If equipped with an ACGO, connect a tube between the ACGO outlet and the Inspiratory port.
   - Set the ACGO switch to the ACGO position.
   - Verify that the Airway Pressure reading increases to 10 cm H_2O in 30 seconds.
4. If not equipped with an ACGO, select End Case and connect a tube to the Inspiratory port.
   - Stretch the tube approximately 5 cm.
   - Occlude the open end of the tube.
   - Release the tension on the tube.
   - Ensure that the Airway Pressure reading increases to between 20 and 40 cm H_2O. If not, repeat the above steps, but stretch the tube a little further.
   - Verify that the Airway Pressure reading does not drop by more than 10 cm H_2O in 30 seconds.

Expiratory check valve

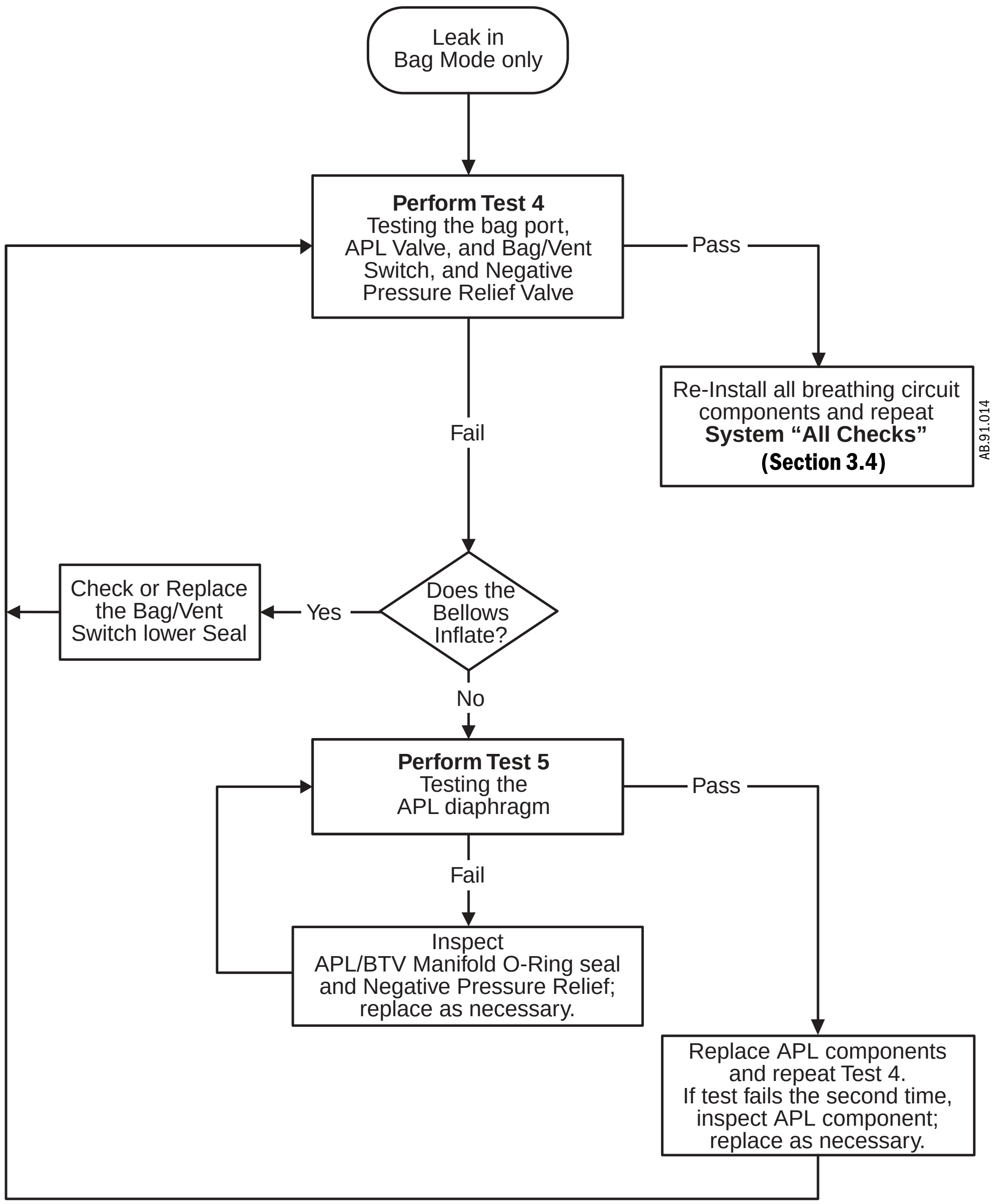
1. Set all gas flows to minimum.
2. Set the Bag/Vent switch to Bag.
3. Fully close the APL valve (70 cm H_2O).
4. Connect a tube between the Inspiratory port and the Bag port.
5. Slowly increase the O_2 flow to achieve 30 cm H_2O.
   - The leak rate is equal to the flow needed to maintain 30 cm H_2O.
   - The leak rate should be less than 500 mL/min.

2.7.2 Breathing System Troubleshooting Flowcharts

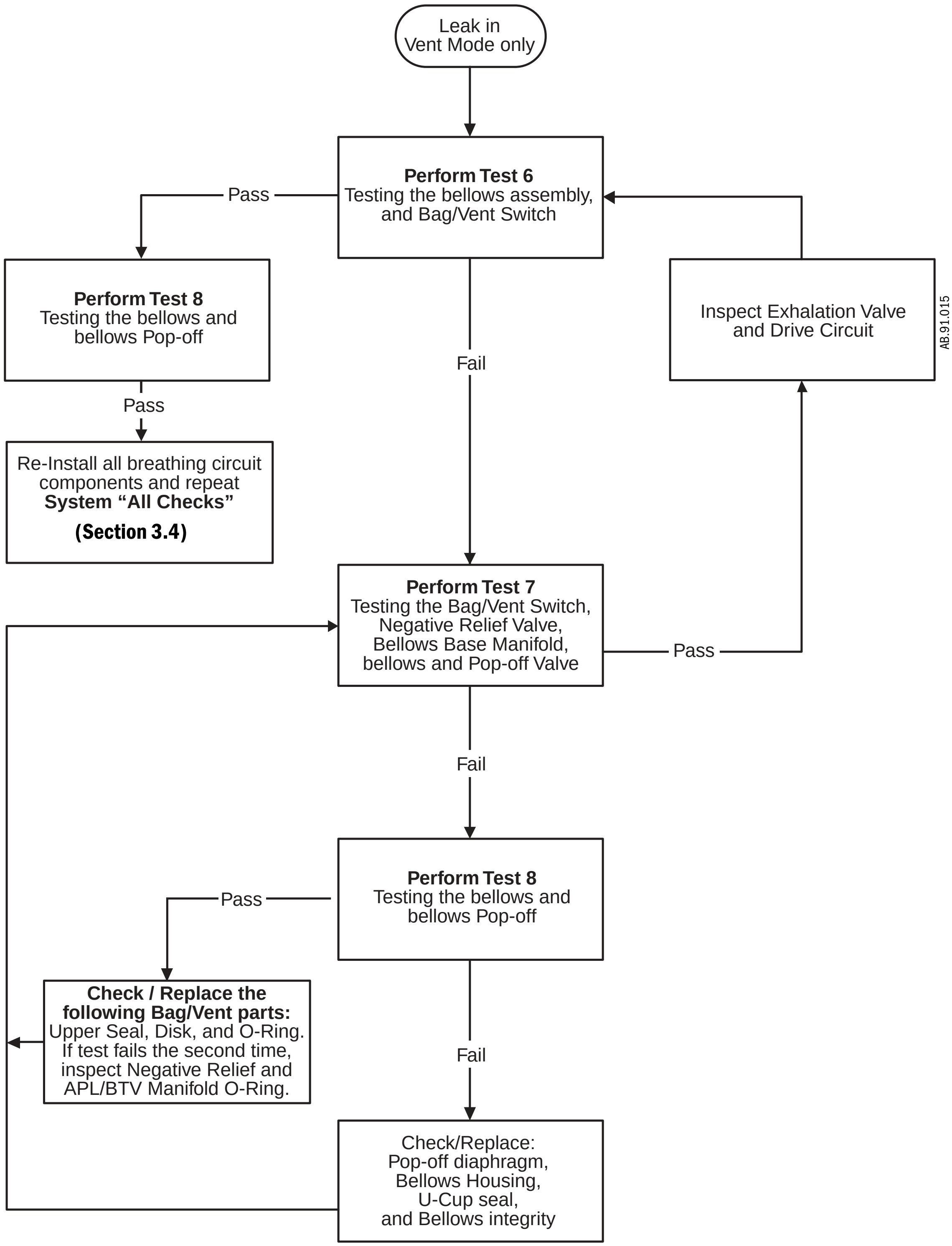


	Vent Mode	Bag Mode
Software ≥ 3.00	Machine Check - System	Machine Check - Circuit
Software < 3.00	Vent Check	Quick Check

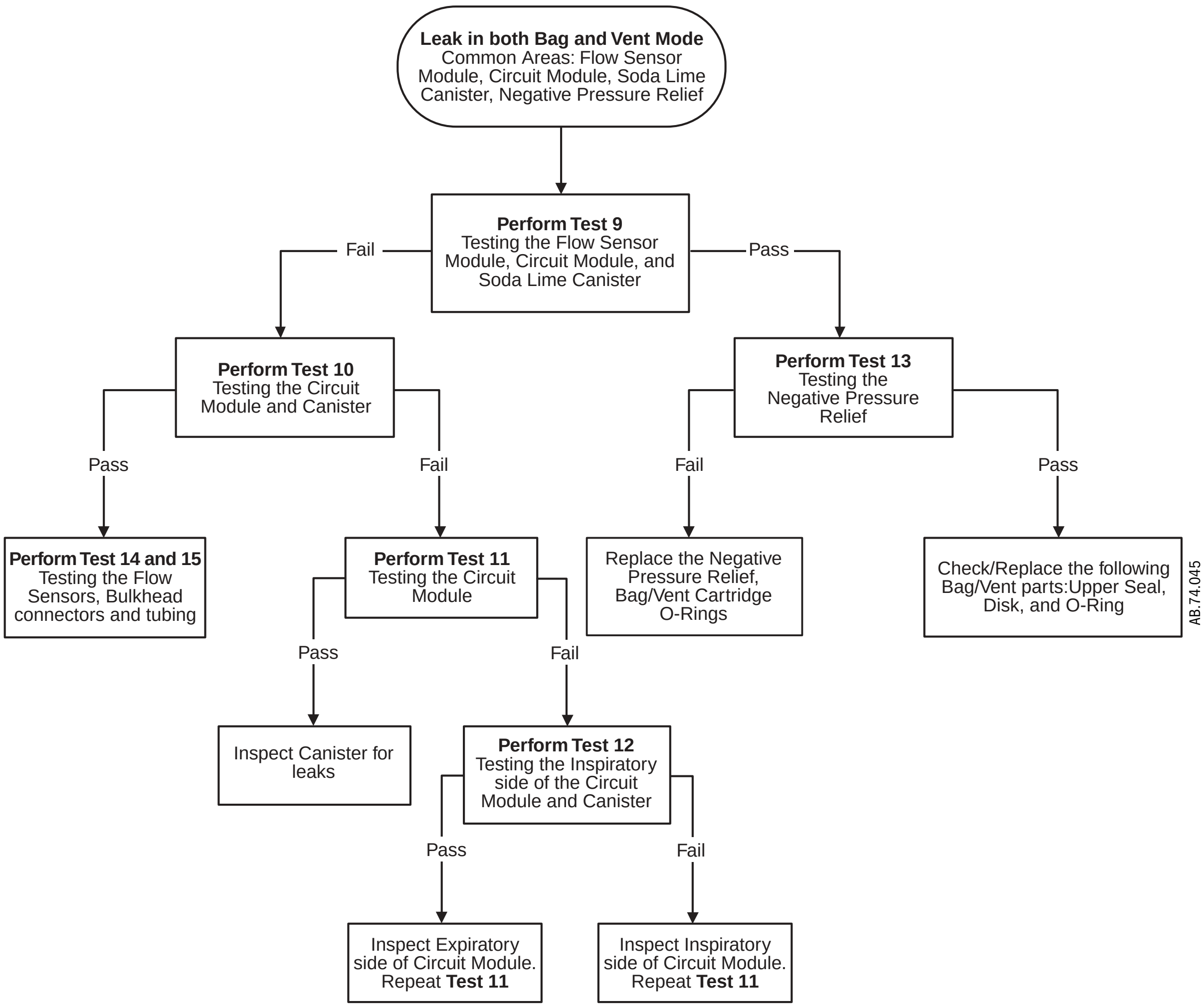
Flowchart ***1***


Leak in
Bag Mode only
Perform Test 4
Testing the bag port, APL Valve, and Bag/Vent Switch, and Negative Pressure Relief Valve
Pass
Re-Install all breathing circuit components and repeat **System "All Checks"** **(Section 3.4)**
AB.91.014
Fail
Does the Bellows Inflate?
Yes
Check or Replace the Bag/Vent Switch lower Seal
No
Perform Test 5
Testing the APL diaphragm
Pass
Fail
Inspect APL/BTV Manifold O-Ring seal and Negative Pressure Relief; replace as necessary.
Replace APL components and repeat Test 4. If test fails the second time, inspect APL component; replace as necessary.

Flowchart 2

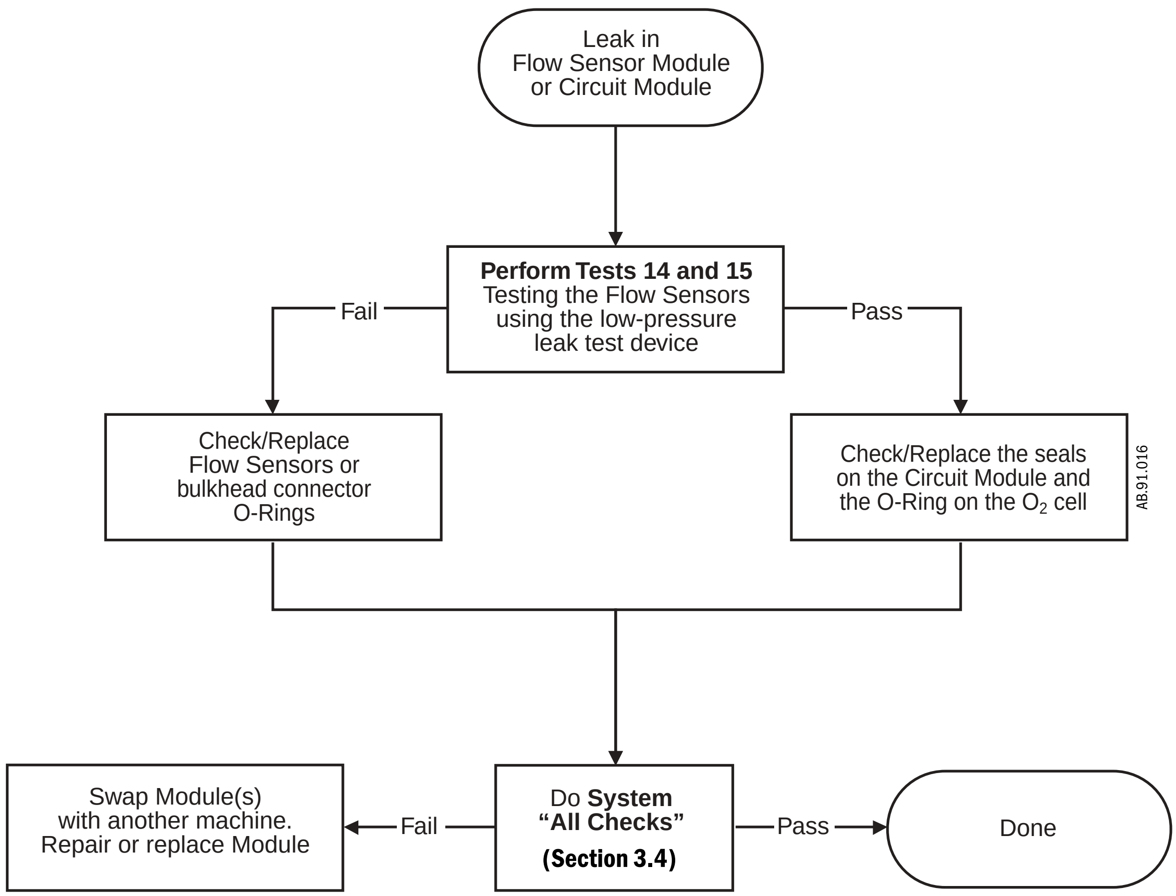

Leak in
Vent Mode only
Perform Test 6
Testing the bellows assembly,
and Bag/Vent Switch
Pass
Perform Test 8
Testing the bellows and
bellows Pop-off
Pass
Re-Install all breathing circuit
components and repeat
System "All Checks"
(Section 3.4)
Fail
Inspect Exhalation Valve
and Drive Circuit
AB.91.015
Perform Test 7
Testing the Bag/Vent Switch,
Negative Relief Valve,
Bellows Base Manifold,
bellows and Pop-off Valve
Pass
Fail
Perform Test 8
Testing the bellows and
bellows Pop-off
Pass
Check / Replace the
following Bag/Vent parts:
Upper Seal, Disk, and O-Ring.
If test fails the second time,
inspect Negative Relief and
APL/BTV Manifold O-Ring.
Fail
Check/Replace:
Pop-off diaphragm,
Bellows Housing,
U-Cup seal,
and Bellows integrity

Flowchart 3



Leak in both Bag and Vent Mode
Common Areas: Flow Sensor Module, Circuit Module, Soda Lime Canister, Negative Pressure Relief
Perform Test 9
Testing the Flow Sensor Module, Circuit Module, and Soda Lime Canister
Fail
Pass
Perform Test 10
Testing the Circuit Module and Canister
Perform Test 13
Testing the Negative Pressure Relief
Pass
Fail
Fail
Pass
Perform Test 14 and 15
Testing the Flow Sensors, Bulkhead connectors and tubing
Perform Test 11
Testing the Circuit Module
Replace the Negative Pressure Relief, Bag/Vent Cartridge O-Rings
Check/Replace the following Bag/Vent parts:Upper Seal, Disk, and O-Ring
AB.74.045
Pass
Fail
Inspect Canister for leaks
Perform Test 12
Testing the Inspiratory side of the Circuit Module and Canister
Pass
Fail
Inspect Expiratory side of Circuit Module. Repeat Test 11
Inspect Inspiratory side of Circuit Module. Repeat Test 11

***Flowchart* 4**


Leak in
Flow Sensor Module
or Circuit Module
Perform Tests 14 and 15
Testing the Flow Sensors
using the low-pressure
leak test device
Fail
Pass
Check/Replace
Flow Sensors or
bulkhead connector
O-Rings
Check/Replace the seals
on the Circuit Module and
the O-Ring on the O2 cell
AB.91.016
Do System
"All Checks"
(Section 3.4)
Fail
Pass
Swap Module(s)
with another machine.
Repair or replace Module
Done

Flowchart 5

7.7.3 Leak Isolation Tests

The previous flowcharts refer you to the following tests.

These tests require the use of the Low Pressure Leak Test Device and the Leak Test Tool Kit (refer to Section 10.1, "Service tools").

The Leak Test Tool Kit includes:

- the Machine Test Tool
- the Circuit Test Tool
- and various Test Plugs

When performing these tests on machines with an ACGO outlet, ensure that the ACGO selector switch is set to the ABS (Circle circuit) position.

Note To perform most of these tests, you must boot the system with the PCMCIA Service Application and access the Diagnostics function as described in the test and detailed in Section 8.

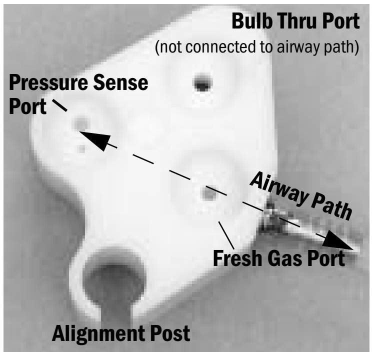
⚠ WARNING Objects in the breathing system can stop gas flow to the patient. This can cause injury or death:

- Do not use a test plug that is small enough to fall into the breathing system.
- Make sure that there are no test plugs or other objects caught in the breathing system.

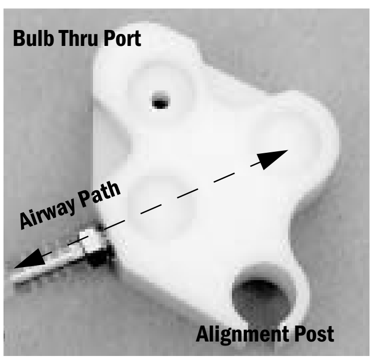
⚠ CAUTION Do not use O_2 Flush for leak isolation tests. Do not leave pressurized systems unattended. High pressure and equipment damage may result.

Test 1 Verifying the integrity of the test tools

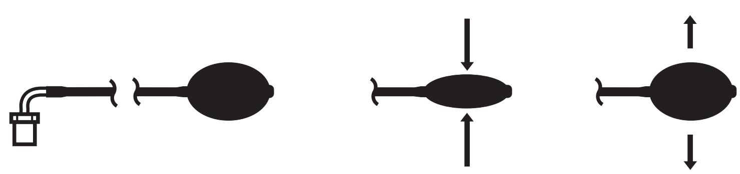
Machine Test Tool
Front View



Back View



1. Verify integrity of low-pressure leak test device.
   - Put your hand on the inlet of the leak test device. Push hard for a good seal.
   - Squeeze the bulb to remove all air from the bulb.
   - If the bulb completely inflates in less than 60 seconds, replace the leak test device.



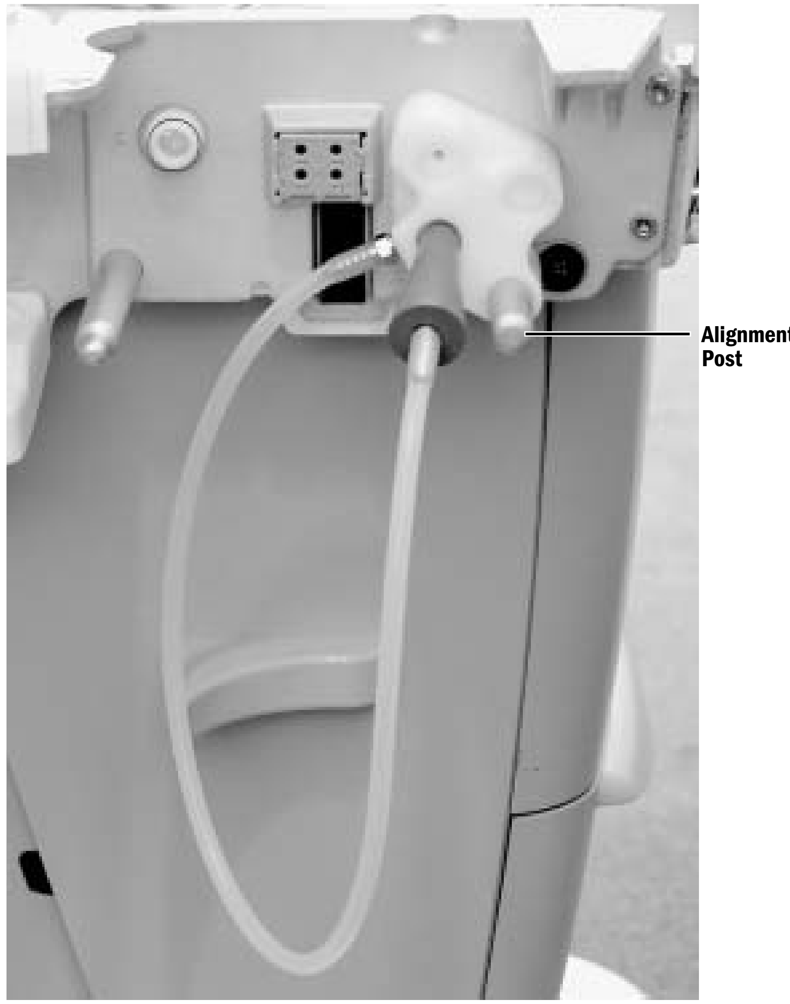
2. Attach the low-pressure leak test device to the Machine Test Tool.
3. Plug the two pressure orifices.
4. Repeatedly squeeze and release the hand bulb until it remains collapsed.
5. If the bulb inflates in less than 30 seconds, locate and correct the leak.

Test 2 Low-pressure leak testing the machine

1. Remove the breathing system from the machine.
2. Attach the Machine Test Tool (using only the Thru Port) and the low-pressure leak test device to **Port 3** of the breathing system interface as shown above.

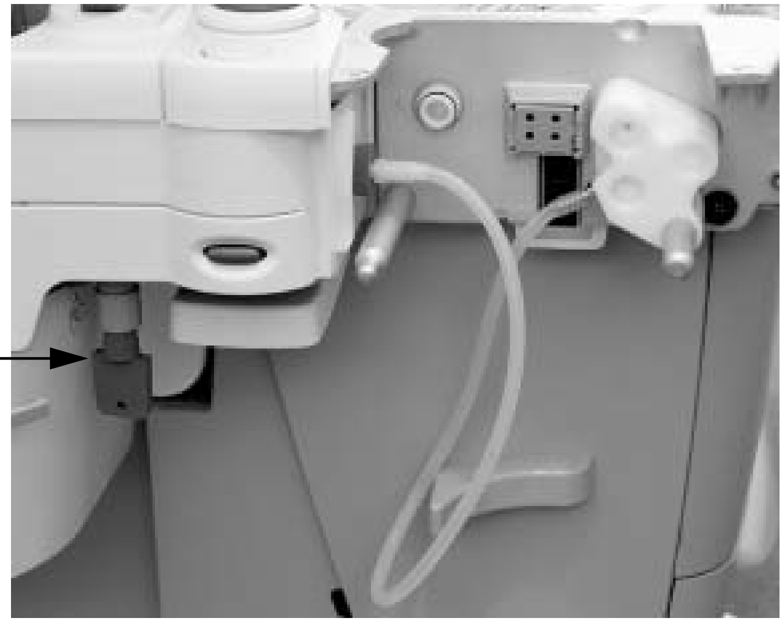
   Note: To prevent damage to the airway pressure transducer, ensure that the gauge port (**Port 1**) is not connected to the Test Tool.
3. On the Main Menu of the Service Application, select ***Vent Diagnostics***.
4. On the Vent Diagnostics page, select ***Status***:
   - Ensure that the ***Circuit Setting*** shows “Circle”. If not, select ***Toggle Circuit*** in the Vent Diagnostics menu selections.
   - For machines with an ACGO outlet, ensure that the ACGO selector switch is set to the ABS (circle breathing circuit).
5. Turn off all vaporizers.
6. Compress and release the bulb until it is empty.
7. If the bulb completely inflates in 30 seconds or less, there is a leak in the low-pressure circuit.

Test 3 Testing the airway pressure transducer, and Port 1 and Port 3 u-cup seals



1. On the Main Menu of the Service Application, select ***Gas Diagnostics***.
2. On the Gas Diagnostics page, select ***O2 Flow***.
3. Set O_2 Flow to **0.2 l/min**.
4. Attach the Machine Test Tool to the breathing system interface ports (using the alignment post) as shown above.
5. Occlude the tapered plug.
6. On the Gas Diagnostics page, reselect the ***O2 Flow*** screen.
   - the Airway Pressure reading should increase.
   - If not, there is a leak in the tested circuit.
7. Set ***O2 Flow*** to OFF.

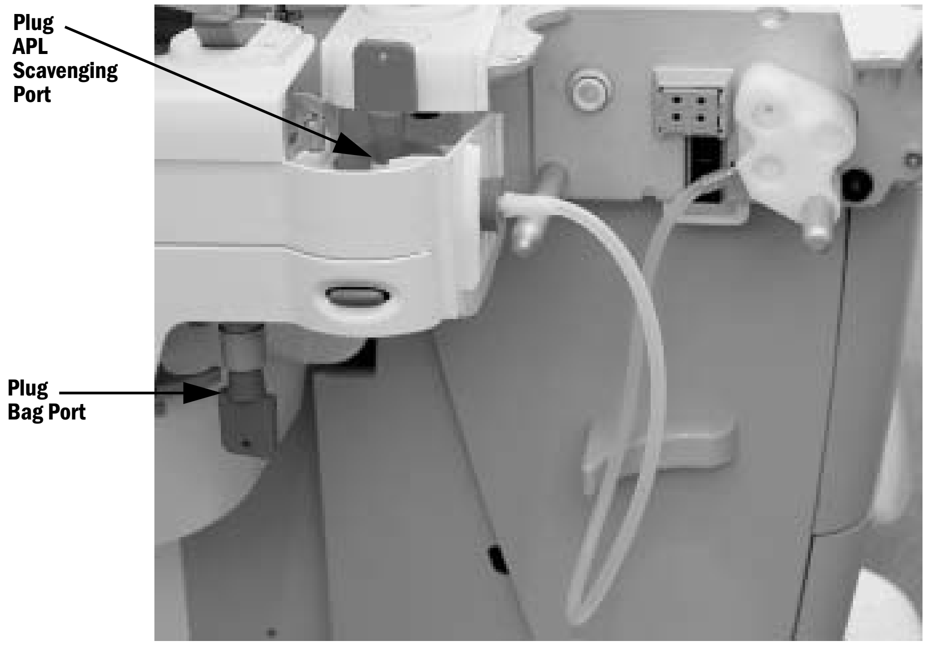
Test 4 Testing the bag port cover, the APL valve, the Bag/Vent switch, and the negative pressure relief valve



1. Separate the Bellows Module from the Circuit Module and re-install the Bellows Module.
2. Occlude the Bag Port connector.
3. Connect the Machine Test Tool to the interface ports as shown above.
4. Set the Bag /Vent switch to Bag and close the APL Valve (70 cm H_2O).
5. On the Main Menu of the Service Application, select ***Gas Diagnostics***.
6. On the Gas Diagnostics page, select ***O2 Flow***.
7. Set O_2 Flow to **0.2 l/min**.
8. On the Gas Diagnostics page, reselect the ***O2 Flow*** screen.
   - Ensure that the Airway Pressure rises to ≥ 30 cm H_2O.

   Note: If the bellows rises, it indicates a leak in the Bag /Vent Switch.
9. Set ***O2 Flow*** to OFF.

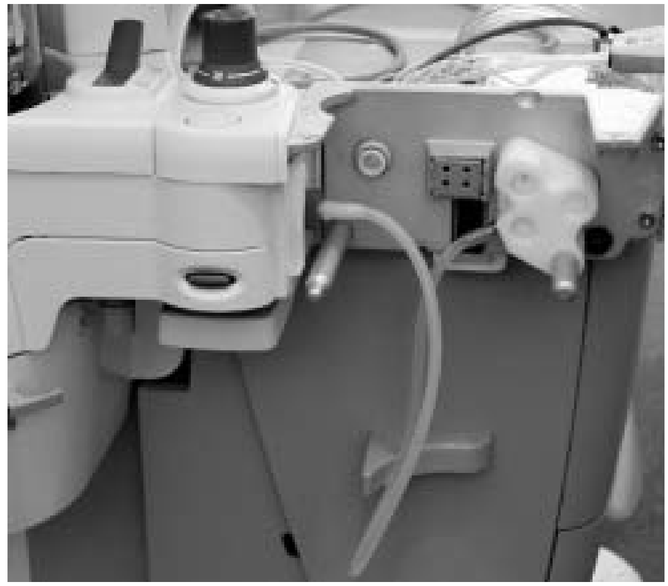
Test 5 Testing the APL diaphragm



Note If required, set up the Machine Test Tool and breathing system as shown in Test 4.

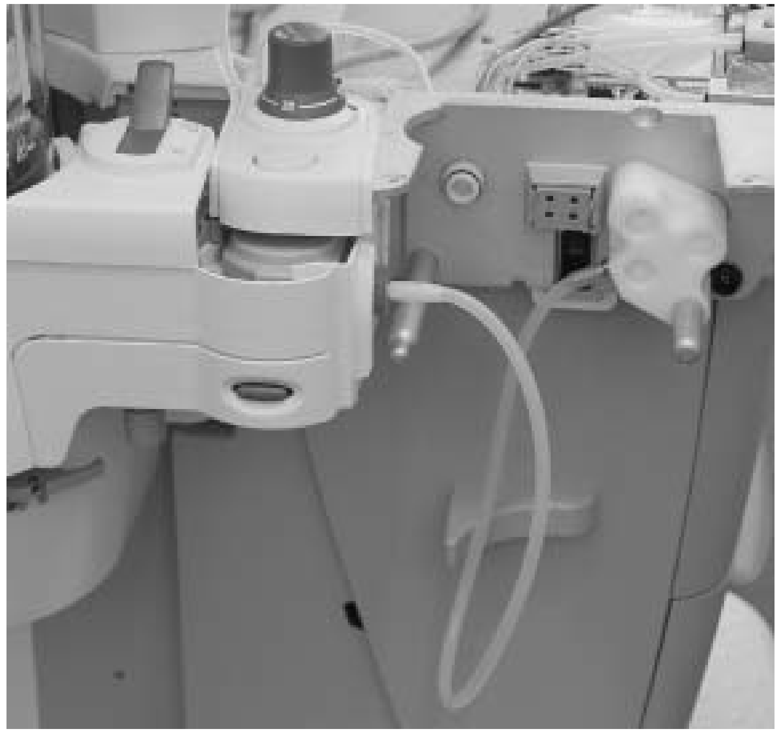
1. Slide the Bellows Module away from the machine.
2. Remove the APL ramp and diaphragm.
3. Insert a Test Plug into the APL scavenging port, as shown above.
4. Slide the Bellows Module partially back onto the machine casting.
5. Ensure that the Bag Port is plugged and that the Bag/Vent switch is set to Bag.
6. On the Main Menu of the Service Application, select ***Gas Diagnostics***.
7. On the Gas Diagnostics page, select ***O2 Flow***.
8. Set O_2 Flow to **0.2 l/min**.
9. On the Gas Diagnostics page, reselect the ***O2 Flow*** screen.
   - Ensure that the Airway Pressure rises to ≥ 30 cm H_2O.
10. Set ***O2 Flow*** to OFF.

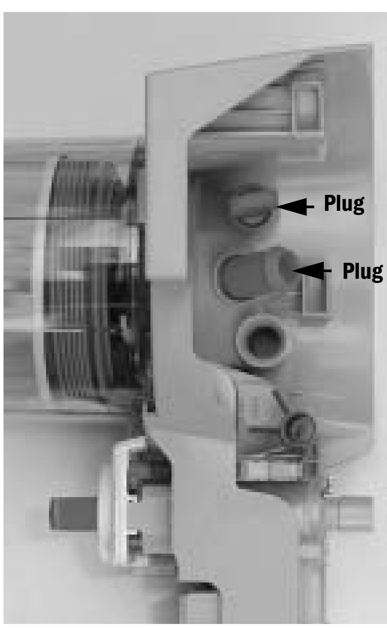
Test 6 Testing the bellows module and the Bag/Vent switch



1. Separate the Bellows Module from the Circuit Module and re-install the Bellows Module.
2. Connect the Machine Test Tool to the interface ports as shown above.
3. Set the Bag/Vent switch to the Vent position.
4. On the Main Menu of the Service Application, select ***Gas Diagnostics***.
5. On the Gas Diagnostics page, select ***Breathing Sys Leak*** to access the Breathing Sys Leak screen (Section 8a.2.6).
6. Set O_2 Flow to **0.2 l/min**.
   - Ensure that the Airway Pressure rises to ≥ 30 cm H_2O.
7. Press the ComWheel to Exit the Breathing Sys Leak test.
8. Set ***O2 Flow*** to OFF.

Test 7 Testing the bellows, the bellows pop-off valve, the bellows base manifold, and the Bag/Vent switch

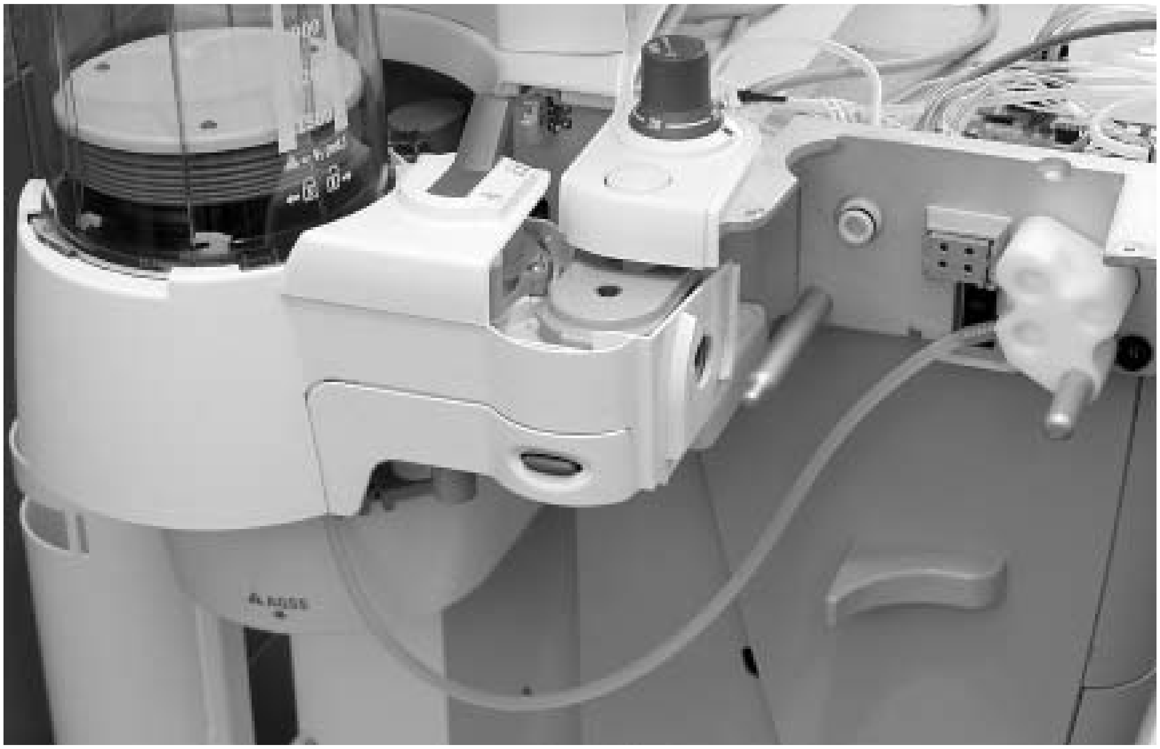




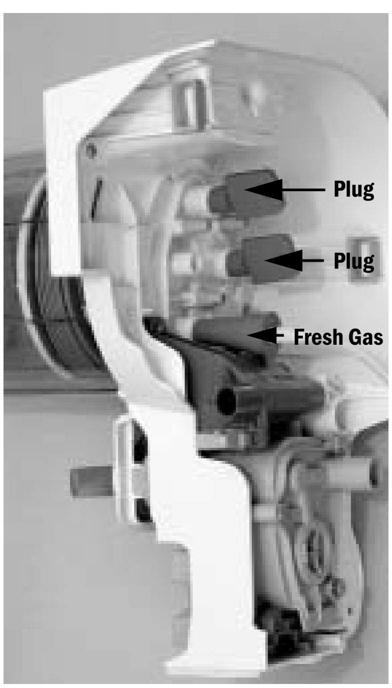
1. Separate the Bellows Module from the Circuit Module.
2. Insert appropriate test plugs into the bellows base manifold as shown to the left.

   Note: Position the bellows assembly so that the bellows remain collapsed as you plug the ports.
3. Set Bag/Vent switch to Vent.
4. Position the bellows upright with the bellows collapsed.
5. Connect the Machine Test Tool to the interface ports as shown above.
6. On the Main Menu of the Service Application, select ***Gas Diagnostics***.
7. On the Gas Diagnostics page, select ***O2 Flow***.
8. Set O_2 Flow to **0.2 l/min**.
9. On the Gas Diagnostics page, reselect the ***O2 Flow*** screen.
   - Ensure that the Airway Pressure rises to ≥ 30 cm H_2O.
10. Set ***O2 Flow*** to OFF.

Test 8 Testing the bellows assembly



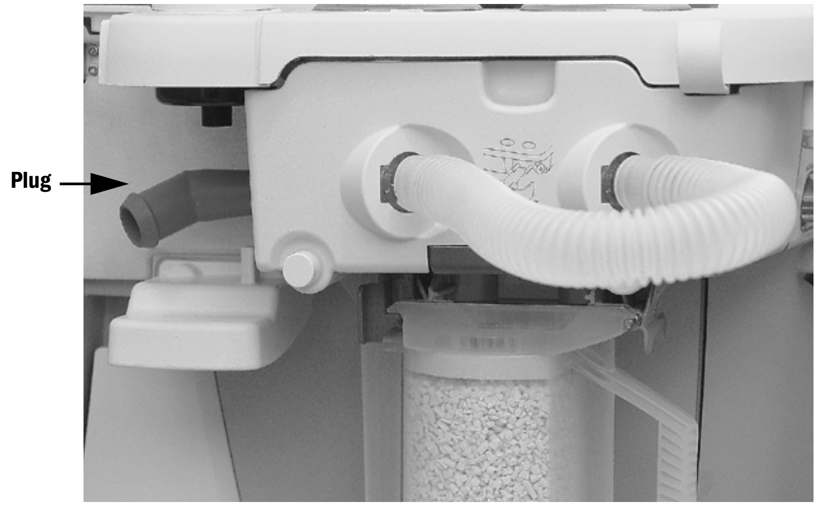
Note If required, set up the Machine Test Tool and breathing system as shown in Test 7.



1. Remove the bellows base manifold from the Bellows Module.
2. Insert appropriate test plugs into the bellows base manifold as shown to the left.

   Note: Position the bellows assembly so that the bellows remain collapsed as you plug the ports.
3. Connect the tapered plug of the Machine Test Tool to the bellows base inlet as shown to the left.
4. Position the bellows upright with the bellows collapsed.
5. On the Main Menu of the Service Application, select ***Gas Diagnostics***.
6. On the Gas Diagnostics page, select ***O2 Flow***.
7. Set O_2 Flow to **0.2 l/min**.
8. On the Gas Diagnostics page, reselect the ***O2 Flow*** screen.
   - Ensure that the Airway Pressure rises to ≥ 30 cm H_2O.
9. Set ***O2 Flow*** to OFF.

Test 9 Testing the flow sensor module, the circuit module, and the soda lime canister

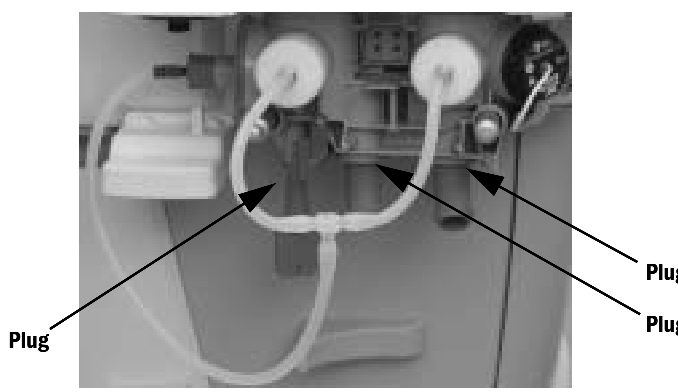


1. Separate the Bellows Module from the Circuit Module and re-install the Circuit/Flow Sensor Module.
2. Connect short tubing between the inhalation and exhalation ports of the breathing system.
3. Insert an appropriate test plug in the outlet port of the Circuit Module.
4. On the Main Menu of the Service Application, select ***Gas Diagnostics***.
5. On the Gas Diagnostics page, select ***O2 Flow***.
6. Set O_2 Flow to **0.2 l/min**.
7. On the Gas Diagnostics page, reselect the ***O2 Flow*** screen.
   - Ensure that the Airway Pressure rises to ≥ 30 cm H_2O.
8. Set ***O2 Flow*** to OFF.
9. Remove the plug to release pressure.

Test 10 Testing the circuit module and the canister

1. Remove the Flow Sensor module.
2. Connect the Circuit Test Tool to the Circuit Module as shown above.
3. Set O_2 Flow to **0.2 l/min**.
4. On the Gas Diagnostics page, reselect the ***O2 Flow*** screen.
   - Ensure that the Airway Pressure rises to ≥ 30 cm H_2O.
5. Set ***O2 Flow*** to OFF.

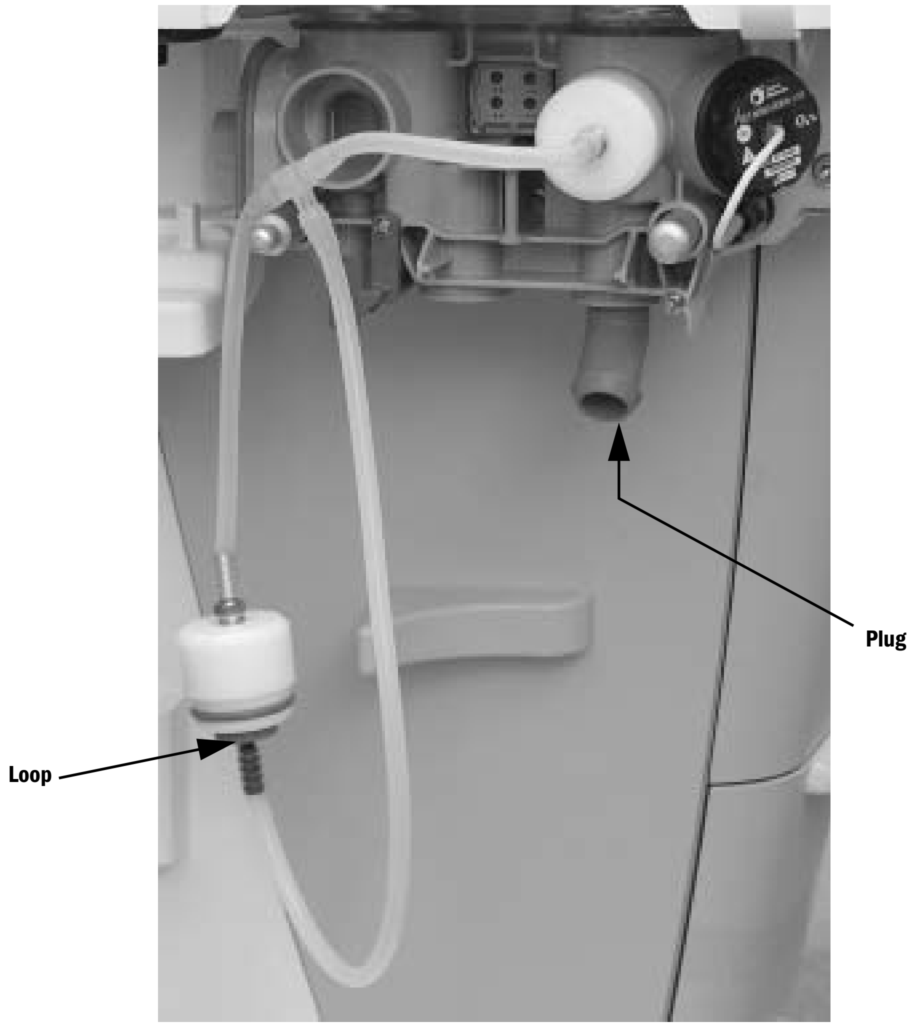
Test 11 Testing the circuit module



Note: If required, set up the machine as in Test 10.

1. Remove the Soda Lime Canister.
2. Using appropriate Test Plugs, plug the three canister ports in the Circuit Module as shown above.
3. Set O_2 Flow to **0.2 l/min**.
4. On the Gas Diagnostics page, reselect the ***O2 Flow*** screen.
   - Ensure that the Airway Pressure rises to ≥ 30 cm H_2O.
5. Set ***O2 Flow*** to OFF.

Test 12 Testing the inspiratory side of the circuit module

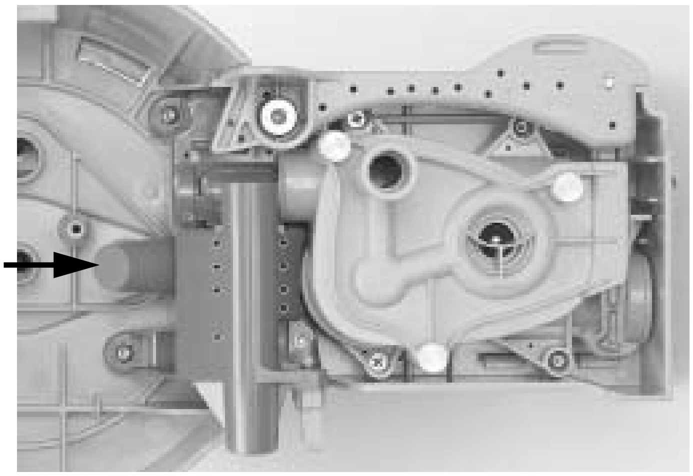


Note: If required, set up the machine as in Test 10 and 11.

1. Connect the Circuit Test Tool to the Circuit Module as shown above.
2. Insert an appropriate test plug in the inspiratory outlet to the canister as shown above.
3. Set O_2 Flow to **0.2 l/min**.
4. On the Gas Diagnostics page, reselect the ***O2 Flow*** screen.
   - Ensure that the Airway Pressure rises to ≥ 30 cm H_2O.
5. Set ***O2 Flow*** to OFF.

Test 13 Testing the negative pressure relief valve

1. Separate the Bellows Module from the Circuit Module.
2. Remove the Bellows Interface Manifold.
3. Insert test plug (recessed end) into the rear Bag/Vent switch port as shown.

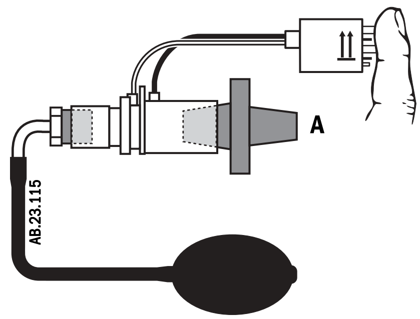


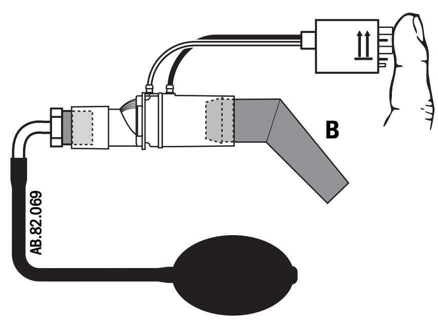
4. Install the Bellows Module.
5. Connect the Machine Test Tool to the interface ports and the Bellows Module as shown above.

6. Set the Bag/Vent Switch to Vent.
7. Set O_2 Flow to **0.2 l/min**.
8. On the Gas Diagnostics page, reselect the ***O2 Flow*** screen.
   - Ensure that the Airway Pressure rises to ≥ 30 cm H_2O.
9. Set ***O2 Flow*** to OFF.

Test 14 Testing the flow sensors only

Note: *To ensure a air-tight seal, use the corresponding plug as illustrated for the original flow sensor (**A**) or the new, moisture resistant (offset) flow sensor (**B**).*

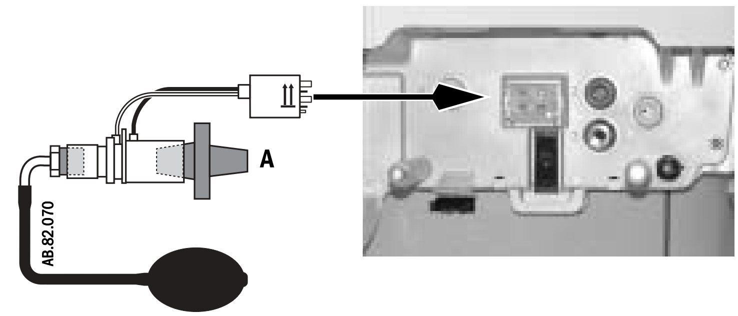


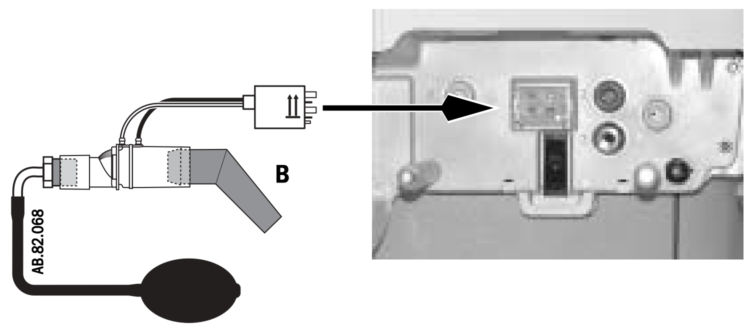


1. Remove the Flow Sensor Module.
2. Plug each Flow Sensor as shown above.
3. Connect the low-pressure leak test device to the open end of the Flow Sensor.
4. Block the connector end of the Flow Sensor with your hand.
5. Compress and release the bulb until it is empty.
6. If the bulb inflates in 30 seconds or less, there is a leak in the flow sensor.
7. If there are no leaks in the flow sensors, go to Test 15.

Test 15 Testing a flow sensor including the Ventilator Monitoring Assembly and interfacing components

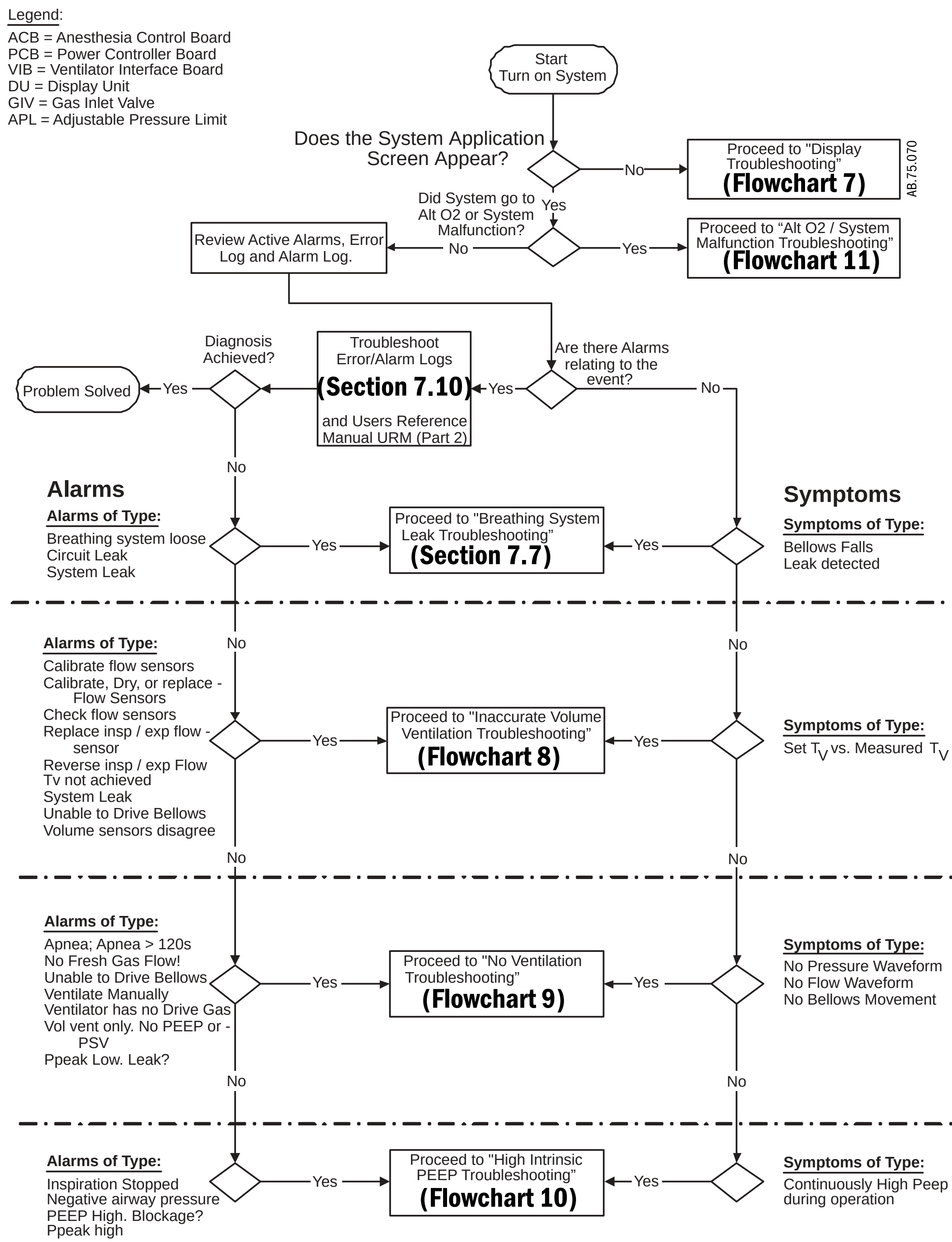
Note: *To ensure a air-tight seal, use the corresponding plug as illustrated for the original flow sensor (**A**) or the new, moisture resistant (offset) flow sensor (**B**).*





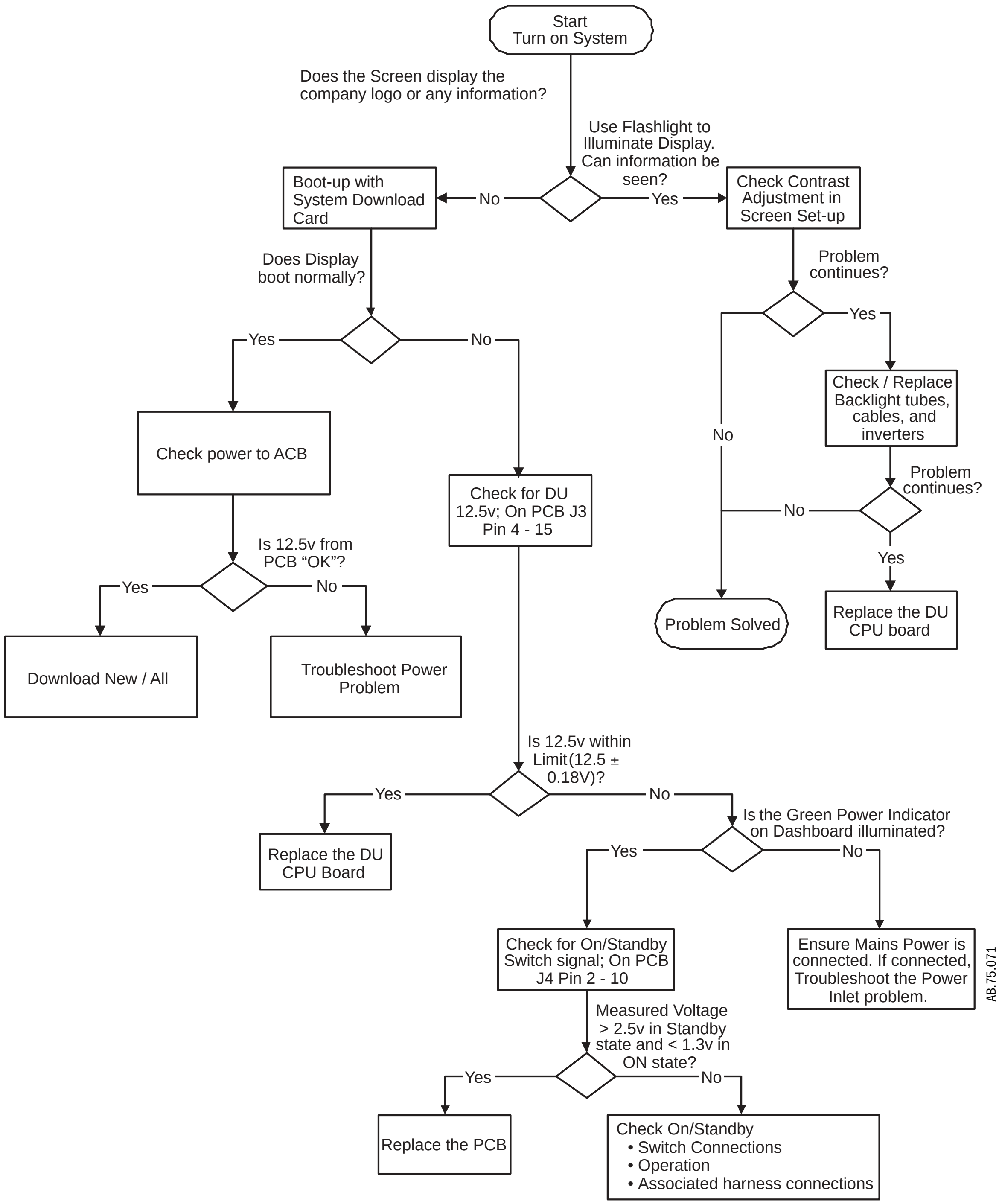
1. Remove Flow Sensors from the Flow Sensor Module.
2. Attach the Flow Sensor to the bulkhead connector.
3. Plug each Flow Sensor as shown.
4. Connect the low-pressure leak test device to the open end of the Flow Sensor.
5. Compress and release the bulb until it is empty.
6. If the bulb inflates in 30 seconds or less, there is a leak. The leak may be through the connector o-rings, in the internal tubing, or in the Transducer on the VIB.

7.8 System Troubleshooting Flowcharts



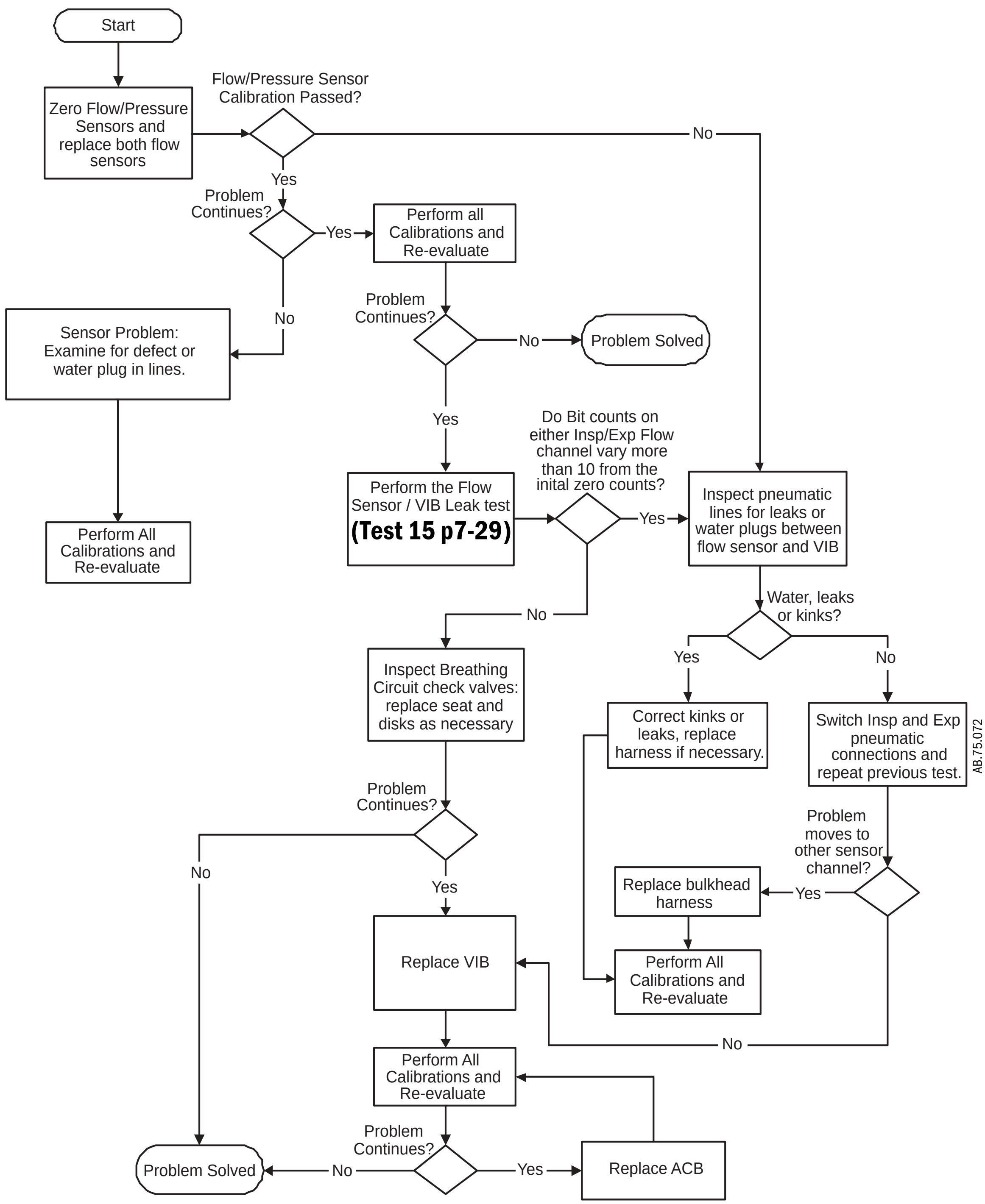
Flowchart ***6***

Display Troubleshooting



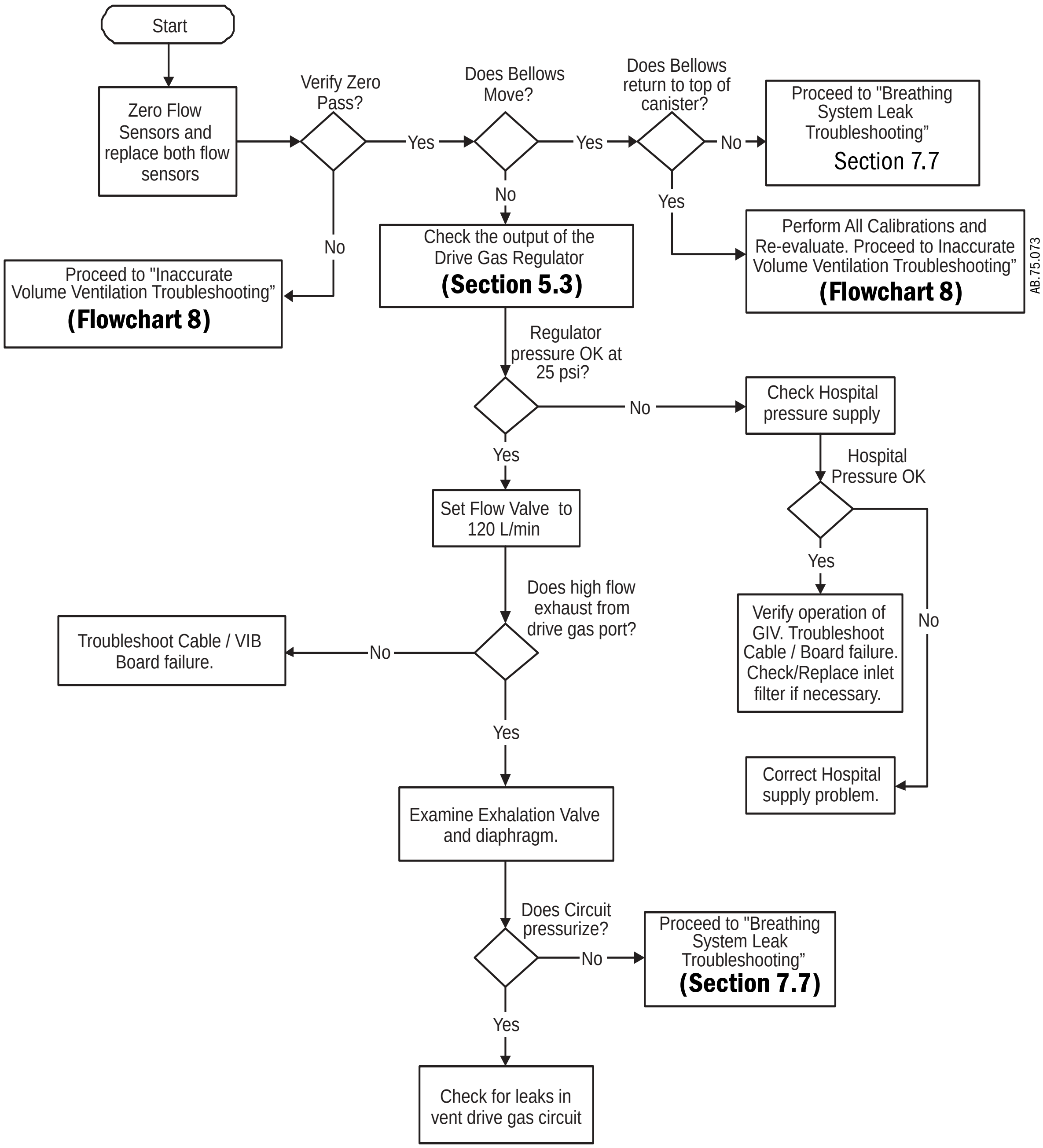
Flowchart ***7***

Inaccurate Volume Ventilation Troubleshooting



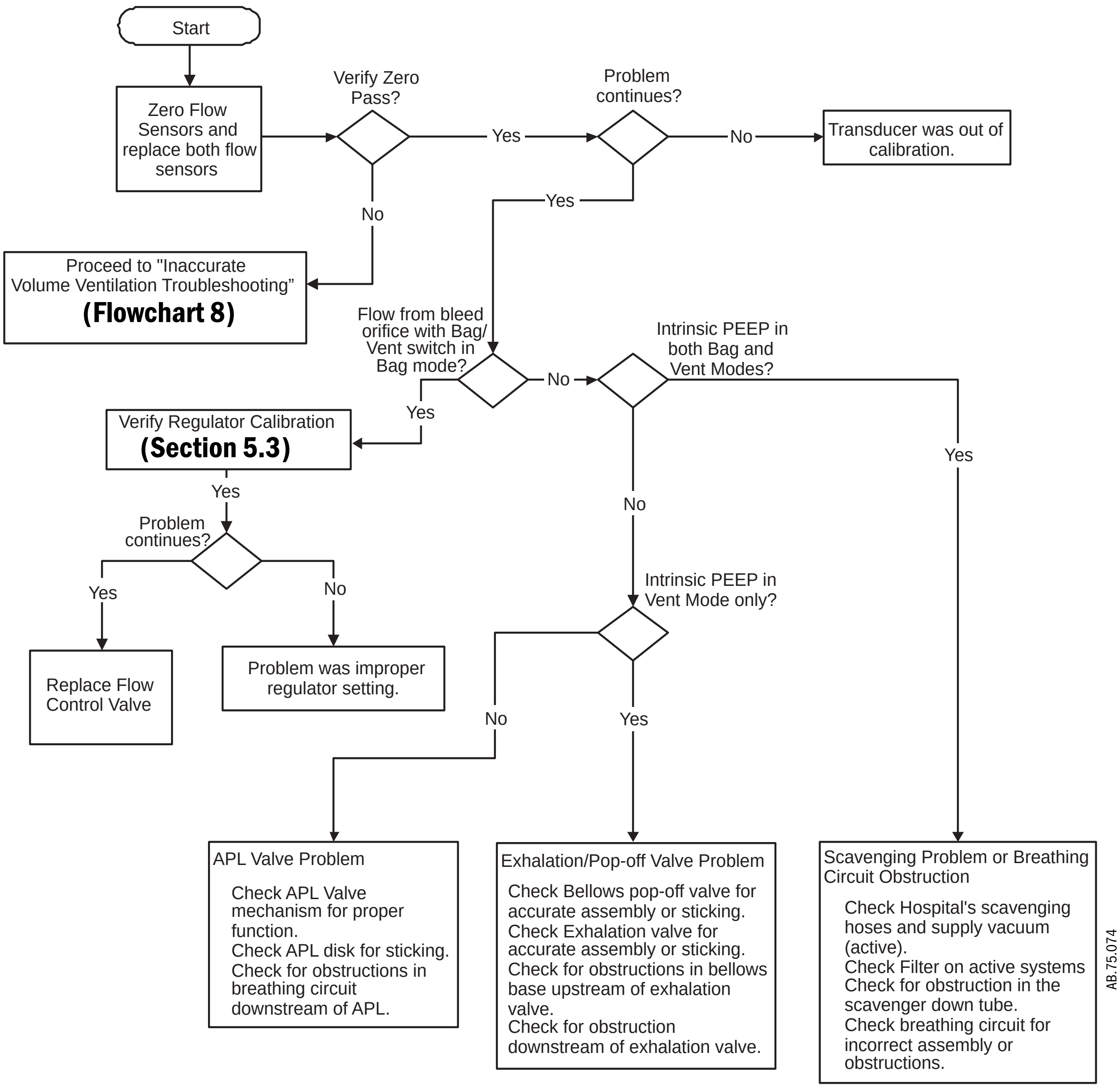
Flowchart **8**

No Ventilation Troubleshooting



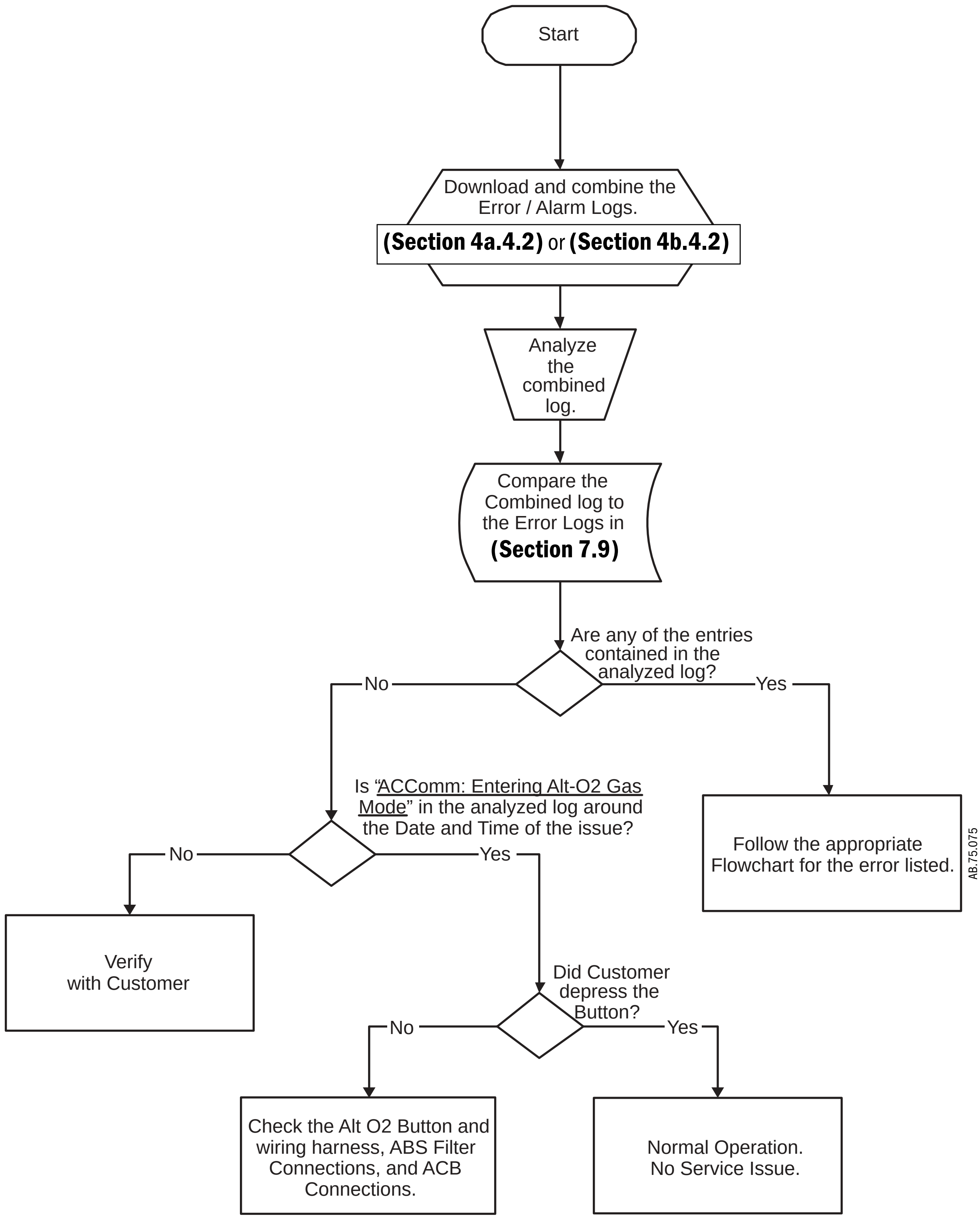
Flowchart **9**

High Intrinsic PEEP Troubleshooting



Flowchart ***10***

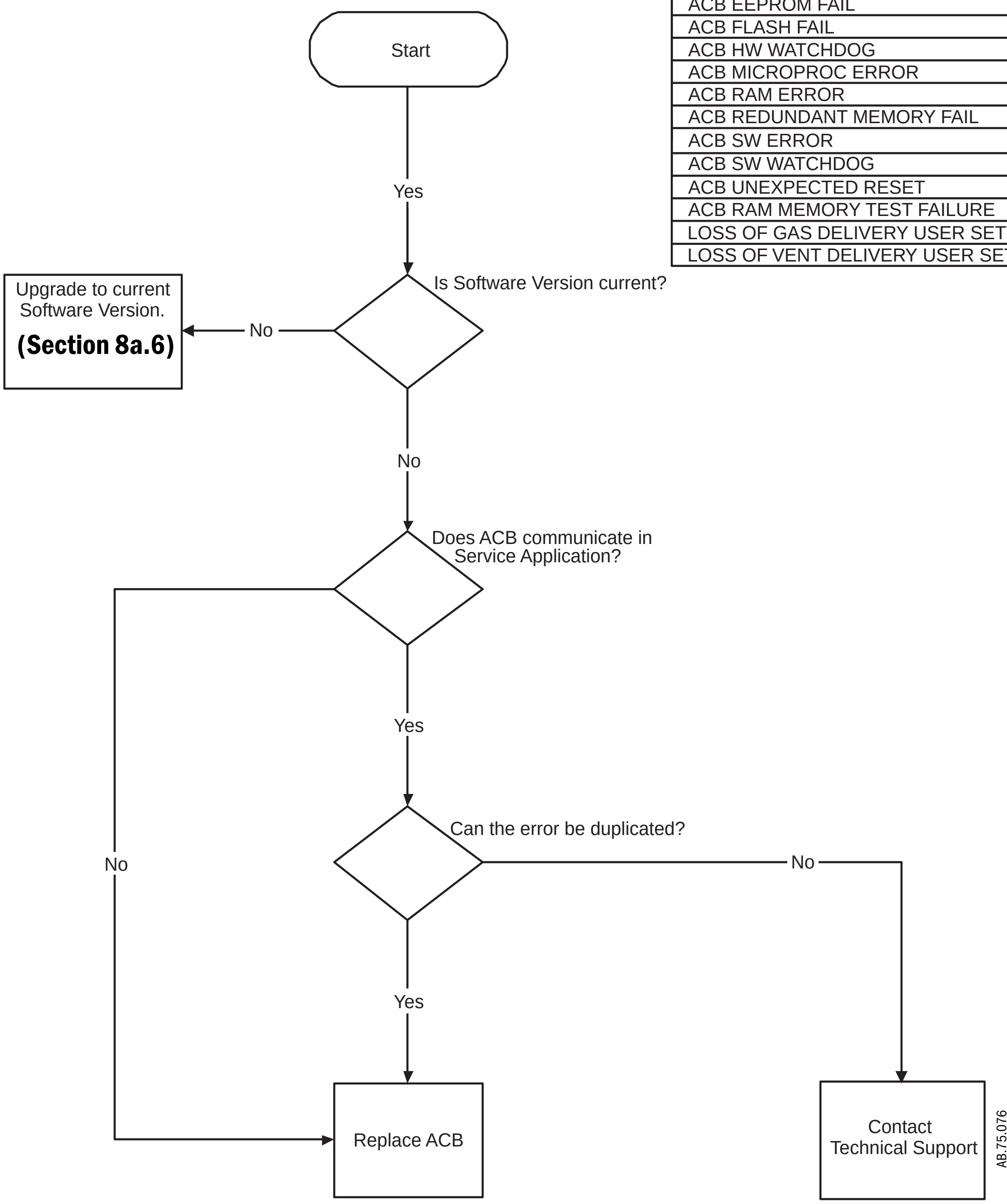
Alternate O_2 / System Malfunction Screen Troubleshooting



Flowchart ***11***

Anesthesia Control Board Troubleshooting

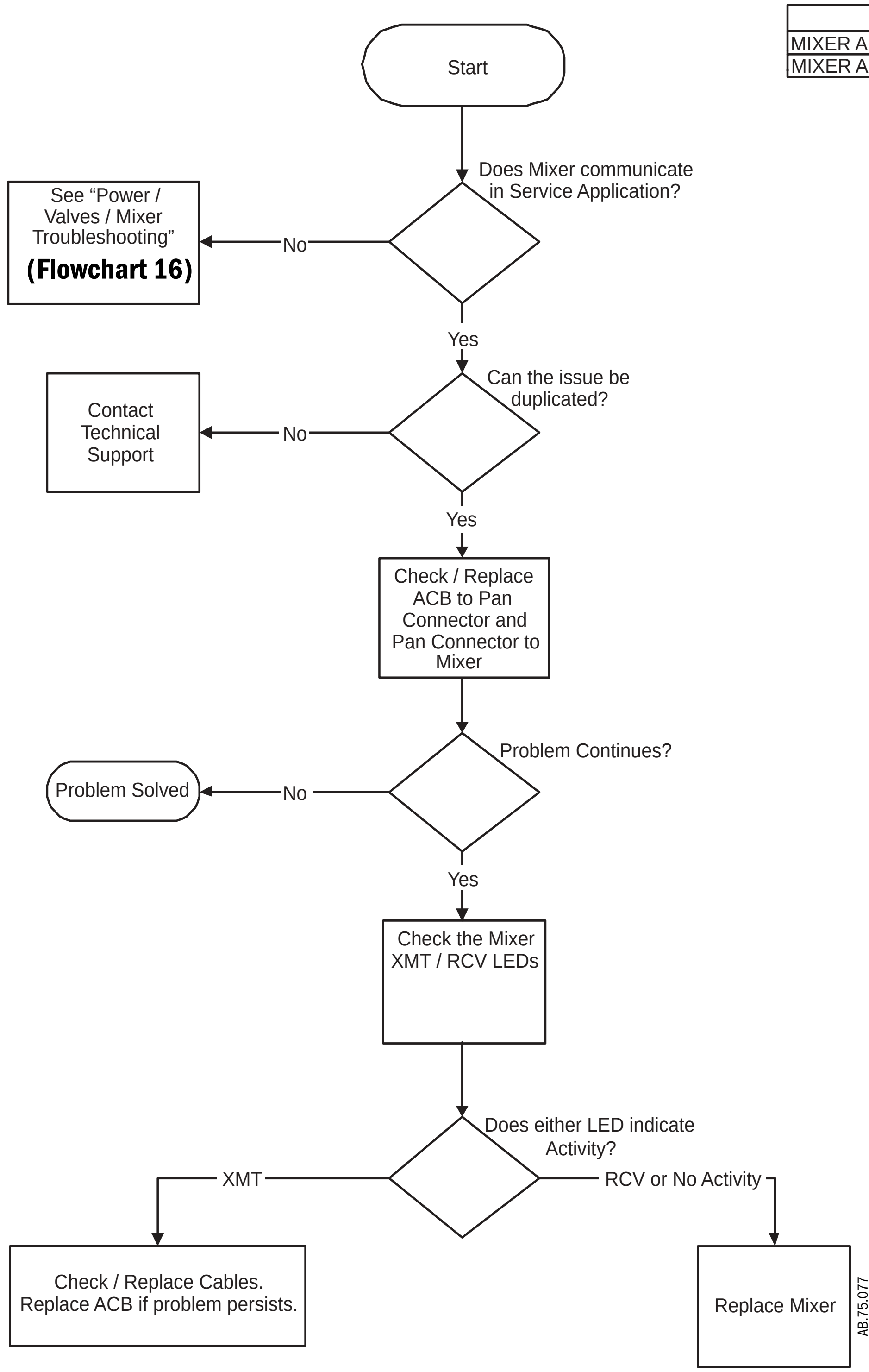
Error Entry
ACB CLOCK SPEED
ACB CPU TEST FAIL
ACB EEPROM FAIL
ACB FLASH FAIL
ACB HW WATCHDOG
ACB MICROPROC ERROR
ACB RAM ERROR
ACB REDUNDANT MEMORY FAIL
ACB SW ERROR
ACB SW WATCHDOG
ACB UNEXPECTED RESET
ACB RAM MEMORY TEST FAILURE
LOSS OF GAS DELIVERY USER SETTINGS
LOSS OF VENT DELIVERY USER SETTINGS



Flowchart ***12***

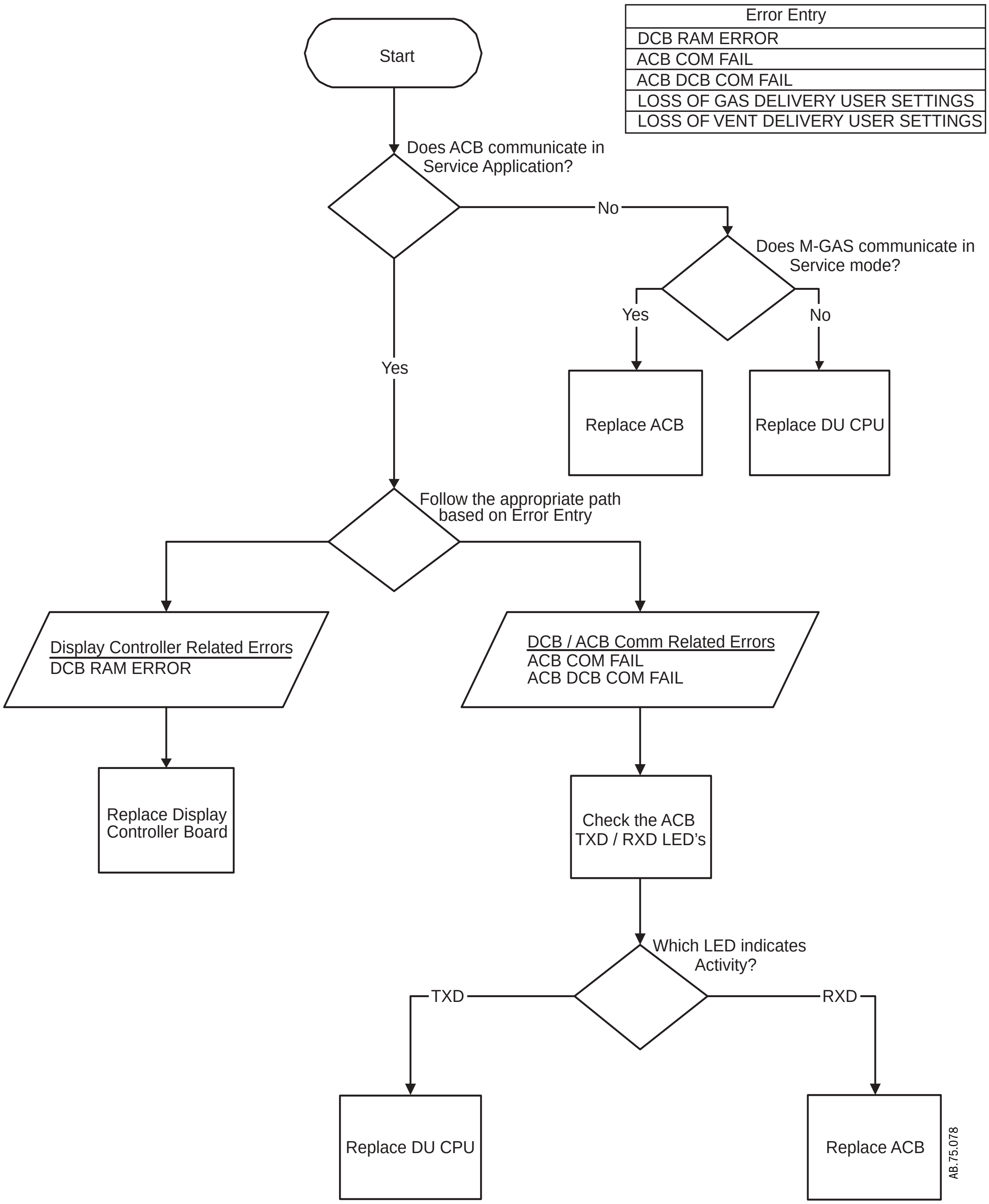
ACB - Mixer Communication Troubleshooting

Error Entry
MIXER ACB COM FAIL
MIXER ACB COM FAILLOST CMD



Flowchart ***13***

DU - ACB Communication Troubleshooting

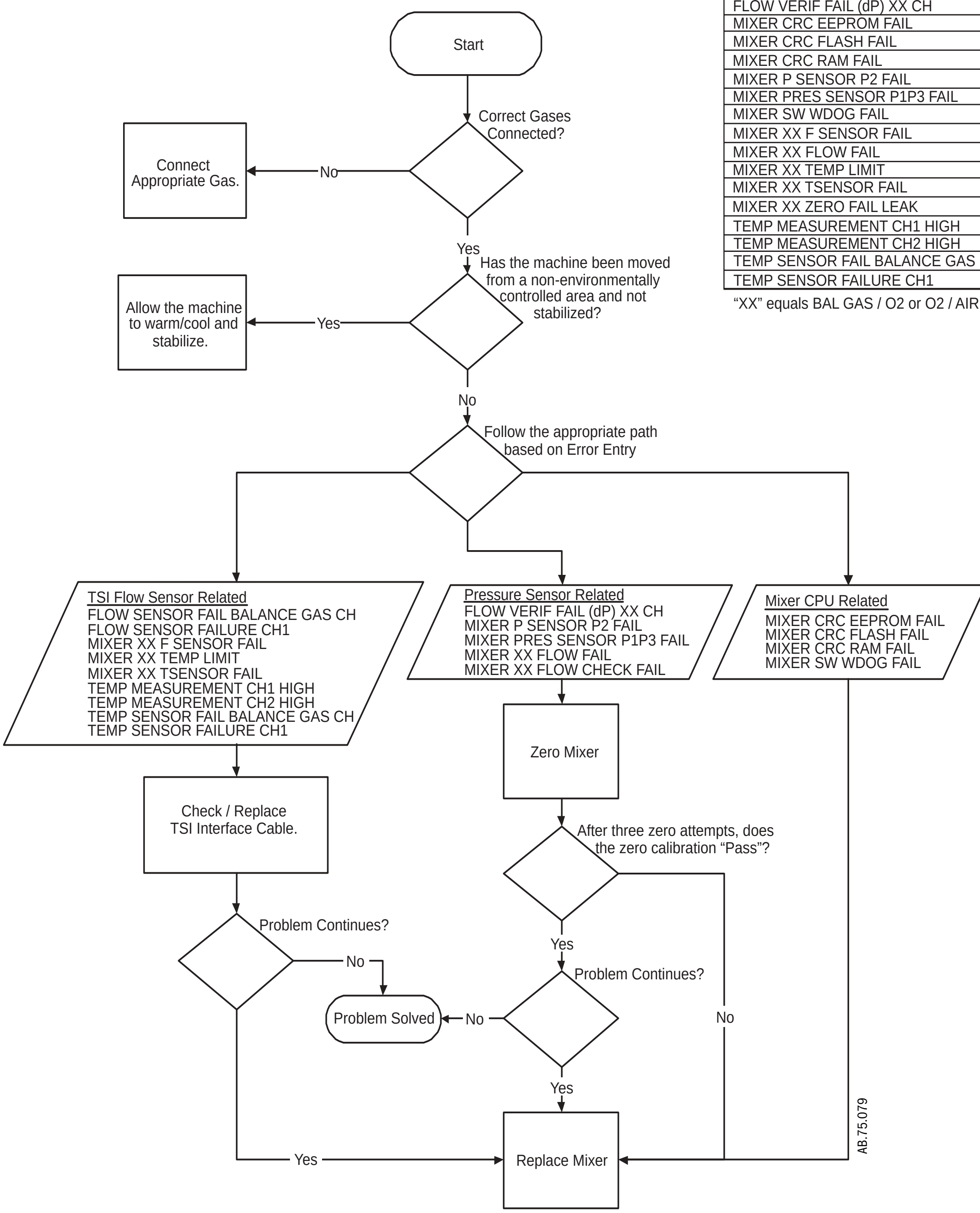


Flowchart ***14***

Mixer Specific Troubleshooting

Error Entry
FLOW SENSOR FAIL BALANCE GAS CH
FLOW SENSOR FAILURE CH1
FLOW VERIF FAIL (dP) XX CH
MIXER CRC EEPROM FAIL
MIXER CRC FLASH FAIL
MIXER CRC RAM FAIL
MIXER P SENSOR P2 FAIL
MIXER PRES SENSOR P1P3 FAIL
MIXER SW WDOG FAIL
MIXER XX F SENSOR FAIL
MIXER XX FLOW FAIL
MIXER XX TEMP LIMIT
MIXER XX TSENSOR FAIL
MIXER XX ZERO FAIL LEAK
TEMP MEASUREMENT CH1 HIGH
TEMP MEASUREMENT CH2 HIGH
TEMP SENSOR FAIL BALANCE GAS CH
TEMP SENSOR FAILURE CH1

“XX” equals BAL GAS / O2 or O2 / AIR / N2O

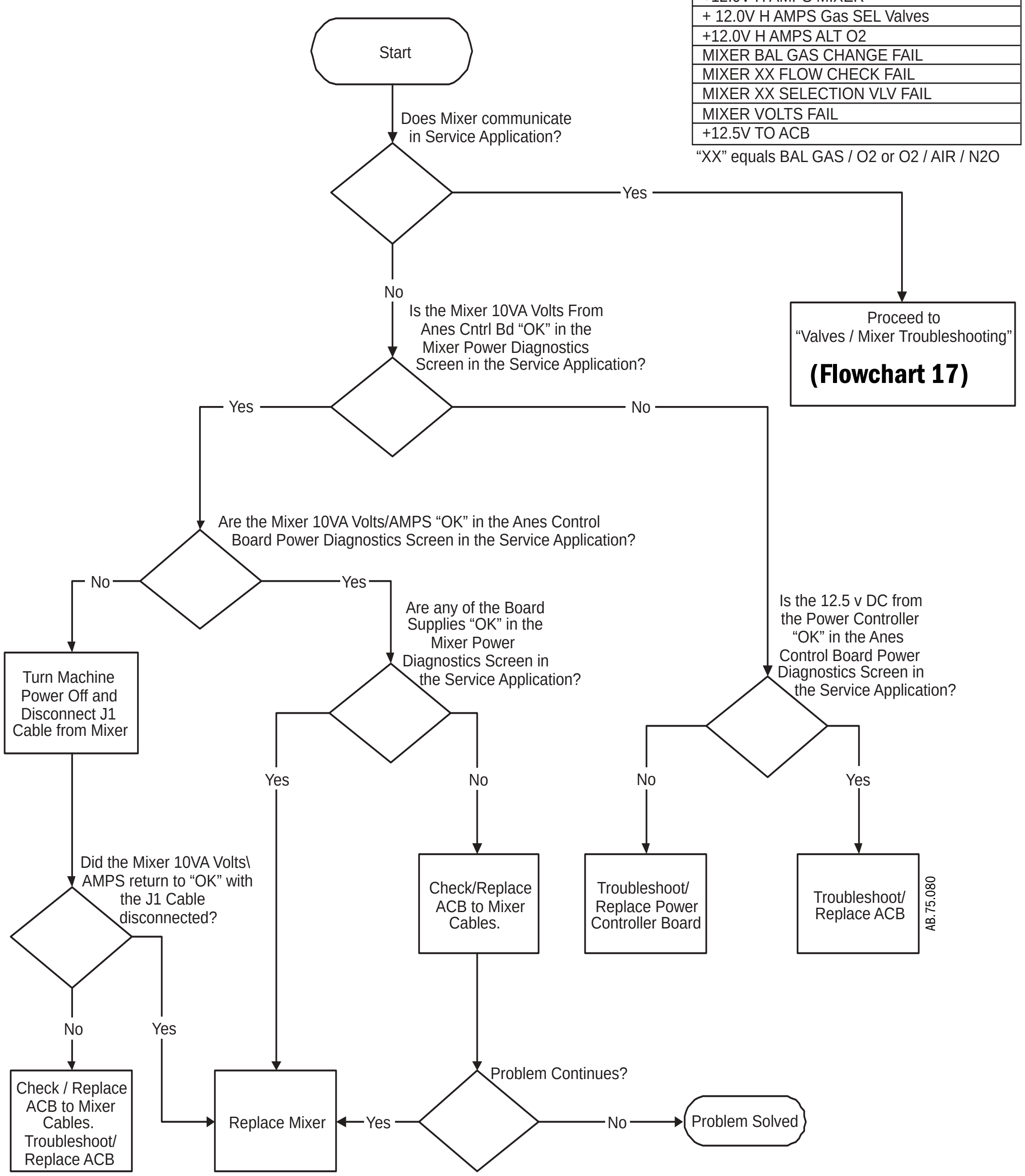


Flowchart **15**

Power - Valves - Mixer Troubleshooting

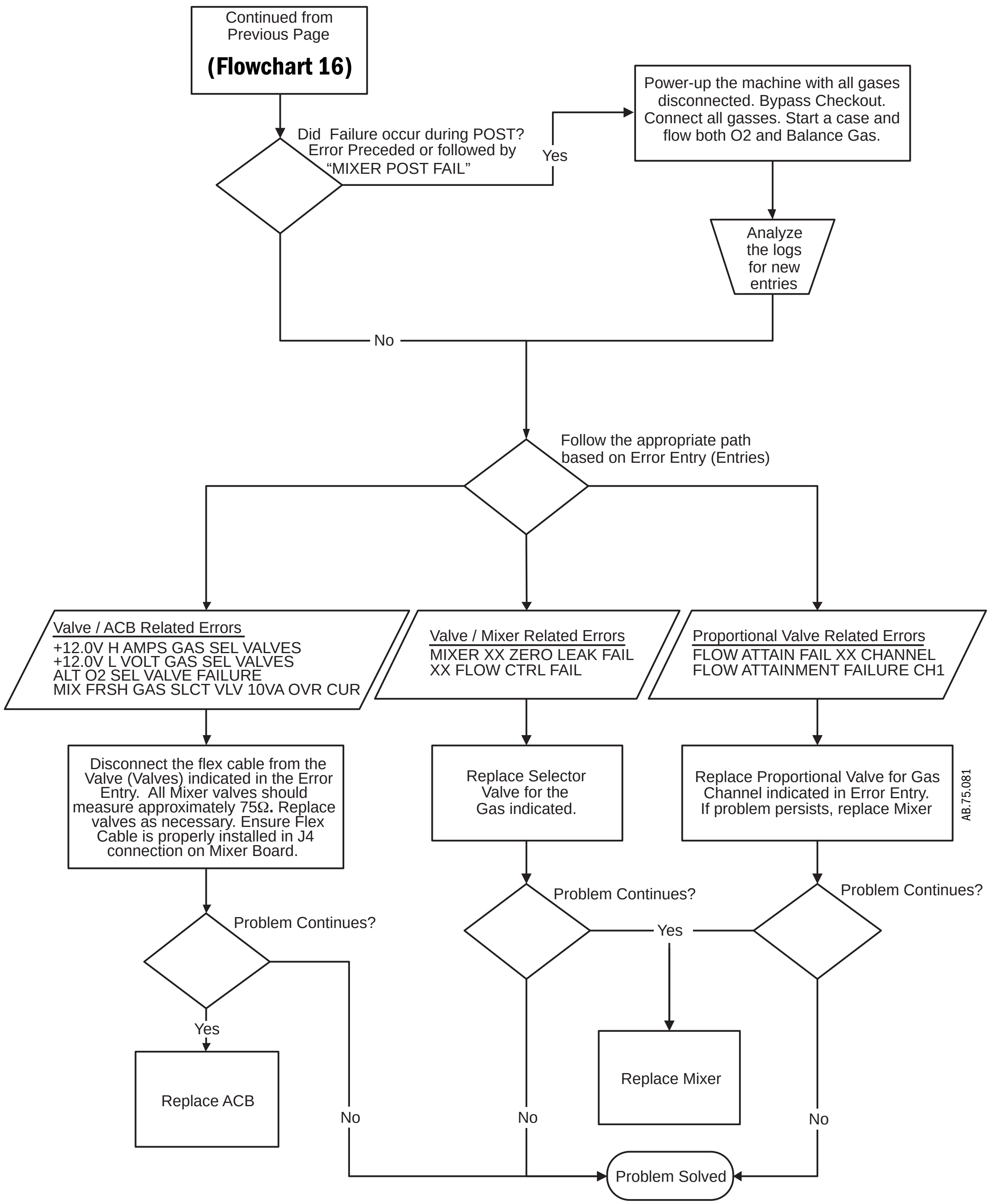
Error Entry
XX FLOW CTRL FAIL
XX PROP VALVE FAIL
FLOW ATTAIN FAIL BAL GAS CHANNEL
FLOW ATTAINMENT FAILURE CH1
+12.0V H AMPS MIXER
+ 12.0V H AMPS Gas SEL Valves
+12.0V H AMPS ALT O2
MIXER BAL GAS CHANGE FAIL
MIXER XX FLOW CHECK FAIL
MIXER XX SELECTION VLV FAIL
MIXER VOLTS FAIL
+12.5V TO ACB

"XX" equals BAL GAS / O2 or O2 / AIR / N2O



Flowchart **16**

Valves - Mixer Troubleshooting



Flowchart **17**

7.9 System Malfunction and Alt O_2 Flowchart Table

Error	Display Type	Flow Chart
+ 12.0V H AMPS Gas SEL Valves +12.0V H AMPS ALT O2 +12.0V H AMPS MIXER +12.5V TO ACB	Alternate O2 Screen	Power - Valves - Mixer Troubleshooting **(Flowchart 16)**
ACB CLOCK SPEED	System Malfunction	Anesthesia Control Board Troubleshooting **(Flowchart 12)**
ACB COM FAIL	System Malfunction	DU - ACB Communication Troubleshooting **(Flowchart 14)**
ACB CPU TEST FAIL	System Malfunction	Anesthesia Control Board Troubleshooting **(Flowchart 12)**
ACB DCB COM FAIL	System Malfunction	DU - ACB Communication Troubleshooting **(Flowchart 14)**
ACB EEPROM FAIL ACB FLASH FAIL ACB HW WATCHDOG ACB MICROPROC ERROR ACB RAM ERROR ACB RAM MEMORY TEST FAILURE ACB REDUNDANT MEMORY FAIL ACB SW ERROR ACB SW WATCHDOG ACB UNEXPECTED RESET	System Malfunction	Anesthesia Control Board Troubleshooting **(Flowchart 12)**
ALT O2 SWITCH FAIL	Alternate O2 Screen	Check Alt O2 Switch Harness and Connections
DCB RAM ERROR	System Malfunction	DU - ACB Communication Troubleshooting **(Flowchart 14)**
FLOW ATTAIN FAIL BAL GAS CHANNEL FLOW ATTAINMENT FAILURE CH1	Alternate O2 Screen	Power - Valves - Mixer Troubleshooting **(Flowchart 16)**
FLOW SENSOR FAIL BALANCE GAS CH FLOW SENSOR FAILURE CH1 FLOW VERIF FAIL (dP) XX CH	Alternate O2 Screen	Mixer Specific Troubleshooting **(Flowchart 15)**
LOSS OF GAS DELIVERY USER SETTINGS LOSS OF VENT DELIVERY USER SETTINGS	System Malfunction	DU - ACB Communication Troubleshooting **(Flowchart 14)**
MIXER ACB COM FAIL MIXER ACB COM FAILLOST CMD	Alternate O2 Screen	ACB - Mixer Communication Troubleshooting **(Flowchart 13)**
MIXER BAL GAS CHANGE FAIL	Alternate O2 Screen	Power - Valves - Mixer Troubleshooting **(Flowchart 16)**

Error	Display Type	Flow Chart
MIXER CRC EEPROM FAIL MIXER CRC FLASH FAIL MIXER CRC RAM FAIL MIXER P SENSOR P2 FAIL	Alternate O2 Screen	Mixer Specific Troubleshooting **(Flowchart 15)**
MIXER POST FAIL	Alternate O2 Screen	See Related Errors in Error Logs
MIXER PRES SENSOR P1P3 FAIL MIXER SW WDOG FAIL	Alternate O2 Screen	Mixer Specific Troubleshooting **(Flowchart 15)**
MIXER VOLTS FAIL	Alternate O2 Screen	Power - Valves - Mixer Troubleshooting **(Flowchart 16)**
MIXER XX F SENSOR FAIL	Alternate O2 Screen	Mixer Specific Troubleshooting **(Flowchart 15)**
MIXER XX FLOW CHECK FAIL	Alternate O2 Screen	Power - Valves - Mixer Troubleshooting **(Flowchart 16)**
MIXER XX FLOW FAIL	Alternate O2 Screen	Mixer Specific Troubleshooting **(Flowchart 15)**
MIXER XX SELECTION VLV FAIL	Alternate O2 Screen	Power - Valves - Mixer Troubleshooting **(Flowchart 16)**
MIXER XX TEMP LIMIT MIXER XX TSENSOR FAIL MIXER XX ZERO FAILLEAK TEMP MEASUREMENT CH1 HIGH TEMP MEASUREMENT CH2 HIGH TEMP SENSOR FAIL BALANCE GAS CH TEMP SENSOR FAILURE CH1	Alternate O2 Screen	Mixer Specific Troubleshooting **(Flowchart 15)**
XX CHK VALVE LEAK	None	Reference TB ADV MSN 04 011
XX FLOW CTRL FAIL XX PROP VALVE FAIL	Alternate O2 Screen	Power - Valves - Mixer Troubleshooting **(Flowchart 13)**

7.10 Technical Alarms

The Error Log includes technical alarms and other error conditions reported by the system.

A technical alarm, as apposed to a parameter alarm, is an alarm condition that exists whether or not a patient is connected to the machine. Technical alarms include:

- Failed state alarms - internal problem prevents normal operation
- Ventilator failure alarms
- Vent Fail. Monitoring Only alarms
- Alternate O_2 state alarms - can be caused by multile issues. The error logs will indicate the failure.

Alarms that do not fit into any particular category but are technical in nature are referred to as a Status alarms in this table.

Source table: AC = Anesthesia Computer
DC = Display Controller
Mixer = Electronic Gas Mixer
PC = Power Controller
Vent = Ventilator Interface

Log entries may be preceded with the subsystem that reported the error condition (example: “ACB: +12.0V H AMPS ALT O2”). The Error Log entry listed below does not include the subsystem prefix that reported the alarm (ACB:).

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
+12.0V H AMPS GAS SEL VALVES	Alternate O_2 Screen.	AC detected high current to the Gas Select Valves.	Medium	AC	Fresh gas select valves +10VA is turned On.
	Disconnect the flex cable from each three-way and NC gas select valves. Measure the resistance of each valve: • should be approximately 75Ω.				
+12.0V H AMPS ALT O2	Alternate O_2 Screen.	AC detected high current.	Medium	AC	Alternate O_2 valve +10VA turned On.
	Disconnect the flex cable from the NO Alternate O_2 valve. Measure the resistance of the NO Alternate O_2 Bypass Valve: • should be approximately 75Ω				
+12.0V H AMPS MIXER	Alternate O_2 Screen.	Status bit shows current high.	Medium	AC	Mixer +10VA turned On.
	In Service Software, under "Anesthesia Control Board Power Diagnostics" (page 2 of Section 8a.1.4), observe that ***Mixer 10VA Amps*** is reported as ***Fail***. Turn off power to the machine and disconnect the system interface harness from the Mixer. If the ***Mixer 10VA Amps*** is now reported as ***OK***, • replace the Mixer. If the ***Mixer 10VA Amps*** is still reported as ***Fail***, • inspect the harnesses from the ACB to PCB and PCB to Mixer for cross connections or damaged pins. • replace the ACB.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
+12.0V H AMPS VENTSIB	Ventilator failure!	Status bit shows current high.	High	AC	Ventilator Interface board 10VA is turned on.
	Reboot system. If problem continues, replace VIB.				
+12.0V H AMPS MGAS	Gas monitoring not available	Status bit shows current high.	Medium	AC	MGAS 10 VA is turned on after 3 consecutive "ACB: +12.0V H AMPS MGAS" error log messages
	Note: "+12.0V H AMPS MGAS" is not the same as "ACB: +12.0V H AMPS MGAS." Note: Single occurrences of "ACB: +12.0V H AMPS MGAS" require no action. Remove Gas Module from the Module Bay. If the problem continues, replace the M-Gas Monitoring board. If the message disappears when module is removed, repair the M-Gas module: • (see S/5 AM Technical Reference Manual for repair instructions).				
+12.0V H AMPS VENT&OUTLET VALVES	Vent Fail. Monitoring Only.	Status bit shows current high.	Medium	AC Vent	Ventilator valves +10VA is On.
	Disconnect the GIV and Insp Flow Valve. Measure the resistance of each valve: • should be approximately 25Ω for the GIV and 75Ω for the Insp Flow Valve.				
+12.0V L VOLT ALT O2		Indicates Low Volts to the Mixer Alt O2 Valve.		ACB	
	This error can be falsely triggered. If no machine issues exist, ignore this entry. If machine issues exist, disconnect the flex cable from the NO Alternate O2 valve. Use a Multimeter to measure the resistance of the NO Alternate O2 Bypass Valve. It should be approximately 75Ω.				
+12.0V L VOLT VENT&OUTLET VALVES		Indicates the Gas Inlet Valve Solenoid or Inspiratory Flow Control Valve is drawing too much power.		ACB	
	Disconnect the GIV and Insp Flow Valve. Measure the resistance of each valve: • should be approximately 25Ω for each valve.				
+12.0V L VOLT VENTSIB		Indicates low voltage to the VIB.		ACB	
	Use the Service Application to isolate VIB from cable.				
+12.5V TO ACB	Alternate O_2	<11.9 or > 12.9 Vdc	High	AC - DC checks the service state.	
	Reboot system. If problem continues, replace the Power Controller board.				

<table>
<tr><th>Error Log Entry</th><th>Alarm Text</th><th>Condition (Basic info)</th><th>Priority</th><th>Source</th><th>Enabling Criteria</th></tr>
<tr><th></th><th colspan="5">Action/Troubleshooting</th></tr>
<tr><td rowspan="2">+5V H AMP GAS SUPPLY XDUCERS</td><td>Cannot read gas supply pressures</td><td>Status bit shows current high.</td><td>Medium</td><td>AC</td><td>Pressure transducer +10VA turned On.</td></tr>
<tr><td colspan="5">Reboot system. If problem continues:
1. With system in Standby, disconnect all gas supply pressure transducers from ABS Filter board.
2. Reboot system.
▪ If problem continues, replace the ACB.
▪ If error is no longer present, set system to Standby and reconnect one pressure transducer at a time.
3. Reboot system and check for error with each transducer connected. Replace the transducer that causes the error to appear.</td></tr>
<tr><td rowspan="2">12 HR TEST</td><td>Turn power Off and On for self tests</td><td>System has been operating for longer than 12 hours without a power up self test.</td><td>Low</td><td>AC - Vent DC checks enable criteria</td><td>System state is in Checkout.</td></tr>
<tr><td colspan="5">At next available time, move the system switch from the On position to the Off position, then back to the On position.</td></tr>
<tr><td rowspan="2">ACB 4.096V ADC REF</td><td>Cannot monitor gas supplies</td><td><4.018 or > 4.176 Vdc</td><td>Low</td><td>AC</td><td></td></tr>
<tr><td colspan="5">Reboot System. If problem continues, replace the ACB.</td></tr>
<tr><td rowspan="2">ACB ADC FAIL</td><td>Cannot monitor gas supplies</td><td>ADC timeout on any MUX channel.</td><td>Low</td><td>AC</td><td></td></tr>
<tr><td colspan="5">Reboot System. If problem continues, replace the ACB.</td></tr>
<tr><td rowspan="2">ACB CLOCK SPEED</td><td>System Malfunction</td><td>AC clock frequency is
> 1.1*(expected value) or
<0.9*(expected value).
AC clock frequency incorrect.</td><td>High</td><td>AC</td><td></td></tr>
<tr><td colspan="5">Reboot System. If problem continues, replace the ACB.</td></tr>
<tr><td rowspan="2">ACB COM FAIL</td><td>System Malfunction</td><td>After establishing initial communication, the DC does not receive any messages from AC in 10 sec.</td><td>High</td><td>DC</td><td></td></tr>
<tr><td colspan="5">Reboot System. If problem continues, replace the ACB.</td></tr>
<tr><td rowspan="2">ACB CPU TEST FAIL</td><td>System Malfunction</td><td>CPU instruction Test Failure</td><td>High</td><td>AC</td><td></td></tr>
<tr><td colspan="5">Reboot System. If problem continues, replace the ACB</td></tr>
<tr><td rowspan="2">ACB DCB COM FAIL</td><td>System Malfunction</td><td>The Anesthesia Computer receives no system state messages from the Display Computer for 10 seconds.</td><td>High</td><td>AC</td><td>Initial communications established.</td></tr>
<tr><td colspan="5">Reboot System. If problem continues, check the ACB to Mixer communication LED’s (or VIB communication LED’s). If the RCV and XMT (or TXD and RXD) LED’s indicate activity, check DU cable connections, replace Display Controller PCB if problem continues. If the RCV and XMT (or TXD and RXD) LED’s indicate no activity, check the Anesthesia Control board connection, replace the Anesthesia Control board if problem continues.</td></tr>
</table>

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
ACB EEPROM FAIL	Memory (EEPROM) failure	Read/Write failure or CRC failure of the EEPROM located on the Anesthesia Control Board.	Low	AC	
	Reboot System. If problem continues, replace the ACB.				
ACB FLASH FAIL	System Malfunction	CRC Failure in code space.	High	AC	
	Reboot System. If problem continues, replace the ACB.				
ACB HW WATCHDOG	System Malfunction	Hardware watchdog fails boot up test, times out, or detects an incorrect code sequence	High	AC	
	Reboot System. If problem continues, replace the ACB.				
ACB MICROPROC ERROR	System Malfunction	Unexpected microcontroller exception (bus error, address error, etc.)	High	AC	
	Reboot System. If problem continues, replace the ACB.				
ACB RAM ERROR	System Malfunction	Memory Test Failure, Multiple bit errors detected.	High	AC	
	Reboot System. If problem continues, replace the ACB.				
ACB REDUNDANT MEMORY FAIL	System Malfunction	A redundantly stored parameter could not be stored properly or was corrupted.	High	AC	
	Reboot System. If problem continues, replace the ACB.				
ACB SW ERROR	System Malfunction	Unexpected software error	High	AC	
	Reboot System. If problem continues, reload ACB Software. If problem continues, replace the ACB.				
ACB SW WATCHDOG	System Malfunction	Software watchdog failed power-up test, timed out, or a software function was delinquent for too long.	High	AC	
	Reboot System. If problem continues, replace the ACB.				
ACB UNEXPECTED RESET	System Malfunction	Unexpected reset of AC	High	AC	
	Reboot system. If problem continues, replace the ACB.				
ACGO	Vol and Apnea monitoring off	Non Circle (ACGO) selected	Low	DC	System has ACGO
	No Service Action Required.				
ACMains POWER FAIL	Plug in power cable. On battery	ACMains_GOOD goes and stays low for at least 300 msec (3 software loops)	Medium	PC	30 minutes of battery power available.
	No Service Action Required.				
AIR PIPE INVALID	Cannot monitor Air pipeline	Air Pipeline pressure is invalid.	Medium	DC	

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
	Check Air Pipeline Supply. Check/Replace Air Pipeline Pressure Transducer.				
AIR PRESS LOW	Air supply pressure low	Air pipeline pressure is less than 252 kPa and the air cylinder has a pressure less than 2633 kPa for one second.	Medium	AC, DC	Air is selected as the balance gas with a non zero flow of air or the ventilator uses air as the drive gas and mechanical ventilation is ON
	Check Air Supply. Check/Replace Air Pipeline/Cylinder Pressure Transducer				
AIR PRESS LOW DURING 21% O2	Air pressure low. Increase O2%.	Air pipeline pressure is less than 252 kPa and the air cylinder has a pressure less than 2633 kPa for one second.	High	AC DC	21% O2 (Air) is selected for fresh gas flow
	Check Air Supply. Check/Replace Air Pipeline/Cylinder Pressure Transducer				
AIRWAY SENSOR CAL ERROR	Calibrate flow sensors	Airway Pressure Sensor zero offset out of range	Low	AC, Vent	Flow sensor detected
	In Service Software, under "Vent Flow and Pressure Diagnostics" (Section 8a.3.2), verify the Airway Pressure counts is 800 ± 250. Disconnect the Black in-line connector in the Patient Airway. If the counts return within specified range, check for occlusions in the Bulkhead harness. If the counts do not return within the specified range, replace the VIB.				
ALT O2 SWITCH FAIL		Alternate O_2 switch status indicates Alt O_2 switch fault. The fault detection condition must persist for 1 second.	Medium	AC	
	Replace the Alt O_2 Switch.				
AUX OUTLET FAIL	No fresh gas flow?	The measured SCGO position does not match commanded position.	High	AC, Vent	
	In Service Software, under "Vent Status" (Section 8a.3.1), view the Circuit Feedback status. If the feedback indicates “Fault”, toggle the Circuit. If the Status changes to match the Circuit setting, check/replace the SCGO/ACGO microswitches.				
BACKUP MODE ENTERED	Backup Mode active	No spontaneous breaths in set period of time (Backup Time (sec)) and 30 seconds has elapsed since starting PSVPro mode.	Low	DC	
	No spontaneous breaths in set period of time (Apnea time) and 30 seconds has elapsed since starting PSVPro mode. No Service Action Required.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
BAL CHANNEL PROP VALVE LEAK FAIL	Alternate O2	Likely caused by a leaky Balance Proportional Valve.		Mixer	
	Replace the proportional valve. Replace Mixer if issue continues.				
BAL FLOW CTRL FAIL		Mixer status bit STS_FLOW_CTRL_CH2_FAIL indicates flow attainment failure.	Medium	AC, Mixer	Balance gas supply pressure OK
	Reboot System. If problem continues, replace the Mixer.				
BAL PROP VALVE FAIL		Mixer status bit STS_CH2_PROPN VALVE FAIL indicates proportional valve failure (over current, etc.)	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
BATT V VERY LOW	Plug in power cable. On battery	Available battery power decreases to between 10 and 5 min	Medium	PC	AC Mains Power Failure in progress.
	Leave the system plugged in to charge the battery. If problem continues, check the battery charge circuit in Service Software. Replace Battery.				
BATTERY <1MIN	System shutdown in <1min	Available battery power is <1min	High	PC	AC Mains Power Failure in progress.
	Leave the system plugged in to charge the battery. If problem continues, check the battery charge circuit in Service Software. Replace Battery.				
BATTERY CHARGE FAIL	No battery backup	The system is in standby and the battery charge current is >4.0 amps. **or** The system is powered on with a battery current >1.7 amps.	Medium	PC	
	Check the battery charge circuit in Service Software. Replace Battery.				
BATTERY EMPTY	System shutdown in <5 min	Available battery power is between 1 and 5 minutes	High	PC	AC Mains Power Failure in progress.
	Leave the system plugged in to charge the battery. If problem continues, check the battery charge circuit in Service Software. Replace Battery.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
BATTERY FAIL	No Battery Backup.	Battery voltage <10.5 V **or** While in bulk, over, or float charging battery is <10.5VDC **or** Battery has been bulk charging for >12 h in Standby or 24 h while powered on. **or** Voltage > 16.5V during bulk or over charging and normal current >0.25 Amps	Medium	PC	
	Leave the system plugged in to charge the battery. If problem continues, check the battery charge circuit in Service Software. Replace Battery.				
BATTERY LOW	Plug in power cable. On battery	Available battery power decreases to between 20 and 30 min	Medium	PC	Mains AC Mains Power Failure in progress.
	Leave the system plugged in to charge the battery. If problem continues, check the battery charge circuit in Service Software. Replace Battery.				
BATTERY MISSING	No battery backup	Any battery voltage is between ±1.0 VDC.	Medium	PC	POST state
	Connect Battery Leave the system plugged in to charge the battery. If problem continues, check the battery charge circuit in Service Software. Replace Battery.				
BATTERY REVERSED CONNECTIONS	No battery backup	Any battery voltage is less than –1.0 VDC	Medium	PC	
	Check Battery Connections				
BATTERY V LOW	Plug in power cable. On battery	Available battery power decreases to between 10 and 20 minutes	Medium	PC	AC Mains Power Failure in progress.
	Leave the system plugged in to charge the battery. If problem continues, check the battery charge circuit in Service Software. Replace Battery.				
BELLOWS COLLAPSED	Unable to drive bellows	Manifold pressure is > Paw + 10 + [0.25*(Insp valve flow)]	Low	AC, Vent	In range Paw and manifold pressure data available and mechanical ventilation On.
	Check the breathing circuit for leaks or hose occlusions. Perform flow sensor calibration. Check drive gas check valve. Check VIB cabling. Replace VIB.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
BREATHING SYSTEM NOT LATCHED	Breathing system loose	Breathing system detection switch indicates breathing system not latched.	Low	AC, Vent	
	Check/replace ABS On switch. Check/replace harness (ABS switches to Filter board).				
CAL DATA FAILURE IN EEPROM	Service calibration advised	Default cal data is being used due to corrupt data in cal region.	Low	AC	
	Perform complete service level calibrations (ventilator).				
CHECK FLOW SENSOR	Check flow sensors	During Mechanical breaths, the measured flow for 6 consecutive breaths, to and from the patient, does not meet certain criteria. No or negative flow on Insp flow sensor during inspiration or negative flow on Exp flow sensor.	Medium	AC, Vent	In-range flow data available during mechanical ventilation
	Check flow sensor connections. Check the breathing circuit. Check VIB sensor tubing for leaks. Perform flow sensor calibration. Check Insp/Exp check valves. Check/Replace flow sensors.				
Circuit check failed.		A message or failure displayed during the system checkout.		DU	
	Perform suggested action and repeat the system Checkout.				
Circuit O2 check skipped.		A message or failure displayed during the system checkout.		DU	
	Perform suggested action and repeat the system Checkout.				
COM ERROR VENT TO ACB	System Malfunction	After regular communications has been established between the Ventilator boundary object and the Vent SIB CPU, a total loss of communications shall be declared if the Ventilator boundary object receives no messages from the Vent SIB CPU for 35 milliseconds.	High	AC Vent	
	Reboot System. If problem continues: 1. Check cabling. 2. Replace VIB. 3. Replace ACB.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
Compatibility failure: No version info in file for subsystem 0.		Indicates a subsystem did not report compatibility information to the Display Unit.		DU	
	Look for other entries in the Error Logs. i.e. “Self-tests Failed”. Perform Software Download.				
Compatibility failure: Software Error		Indicates a subsystem did not report compatibility information to the Display Unit.		DU	
	Look for other entries in the Error Logs. i.e. “Self-tests Failed”. Perform Software Download.				
Compatibility incomplete: No versions from Vent SIB		Indicates the Compatibility information for the Ventilator Interface Board does not match the Compatibility Table created during the last software download or the GIV Test did not pass.		DU	
	Check for other errors (Self-tests Failed). Perform Download New to rebuild Compatibility Table. If persists, replace VIB.				
Compatibility incomplete: No versions received from Vent SIB		Indicates the Compatibility information for the Ventilator Interface Board does not match the Compatibility Table created during the last software download or the GIV Test did not pass.		DU	
	Look for other entries in the Error Logs. i.e. “Self-tests Failed”. Replace the GIV Solenoid. Check the operation of the Gas Inlet Valve operation. Perform Software Download.				
COOLING FAN CURRENT LOW FAILURE		Indicates the Pan Fan is drawing too little current.		Mixer	
	Replace Fan. Replace Mixer.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
CPU FAN SPEED FAIL	Cooling fans failed. May overheat.	CPU fan speed less than 50% of nominal speed	Medium	DC	
	This message relates to the CPU heatsink fan in the HPDU. • Turn on unit with back cover removed and verify CPU fan is not working. • Verify fan connector is plugged in. • Replace CPU fan.				
CPU OVERHEAT	Cooling fans failed. May overheat.	Temperature reading of either DU thermistor > 60 degrees C	Medium	DC	
	This message relates to the case fan in the HPDU. • With unit running, remove the fan filter from back of unit and feel if fan is working. • Open case and check that fan connector is plugged in. • Replace case fan.				
DCB RAM ERROR	System Malfunction	Self test failure or multi bit error detected.	High	DC	
	Reboot System. If problem continues, replace the Display Controller Board.				
DC COMMANDED AC TO FAILURE		Indicates the Display Controller detected issues and commanded the Anesthesia Controller to safe state.		DC	
	Check for other errors in the error logs (Compatibility failure, Compatibility incomplete, etc.).				
DC: FRONT PANEL KEY STUCK		Indicates a stuck Keypad or encoder on the Display.		DU	
	Replace the Keypad / Encoder.				
DRIVE GAS LOST	Ventilator has no drive gas	O_2 supply low if O_2 is selected drive gas OR AIR supply low if Air is selected drive gas.	High	AC DC checks enable criteria	Mechanical Ventilation is ON.
	Connect O_2 or AIR supply. See Action/Troubleshooting for O_2 PRESS LOW or AIR PRES LOW.				
EXP FLOW SENSOR CAL ERROR	Calibrate flow sensors	Exp Flow Sensor zero offset out of range	Low	AC, Vent	Flow sensor detected
	In Service Software, under "Vent Flow and Pressure Diagnostics" (Section 8a.3.2), verify the Expiratory Flow counts is 2050 ± 250. Disconnect the Blue and Yellow in-line connectors. If the counts return within specified range, check for occlusions in the Bulkhead harness. If the counts do not return within the specified range, replace the VIB.				
EXP FLOW SENSOR EEPROM FAILURE	Replace exp flow sensor	EEPROM cal data read failure	Low	AC, Vent	
	Replace Exp Flow Sensor.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
Action/Troubleshooting					
FAN FAIL	Cooling fan needs service. System OK	Fan Power Status Bit is Low (FAN1_GOOD).	Medium	PC	Communication between Power Controller and Display Computer.
	Connect cooling fan. Replace cooling fan.				
FANS FAIL	Cooling fans failed. May overheat.	Both of the Fan Power Status Bits are Low (FAN1_GOOD, FAN2_GOOD)	Medium	PC	Communication between Power Controller and Display Computer.
	Connect cooling fans. Replace cooling fans. Replace PCB.				
FLOW ATTAINMENT FAILURE CH1		Indicates the commanded flow through the O2 Gas channel does not match the measured flow via the flow sensor and the differential pressure transducers.		Mixer	
	Replace the O2 Proportional Valve. Replace the Mixer.				
FLOW SENSOR CAL ERROR	Calibrate flow sensors	Insp or Exp flow sensor or the airway or manifold pressure sensor zero offset out of range (flow calibration failure)	Low	AC, Vent	Flow sensor detected
	See associated Errors. i.e. EXP FLOW SENSOR CAL ERROR or AIRWAY SENSOR CAL ERROR				
FLOW VALVE CURRENT FAILURE		Indicates the current feedback from the Insp Flow Valve was incorrect for seven consecutive readings.		ACB	
	In the Service Software / Vent Flow & Pressure Diagnosis, increase the Flow Valve counts and view the Flow Valve Current mA and Counts.				
FLOW_VALVE_DAC_FAILURE		Indicates the current feedback from the Insp Flow Valve was incorrect for seven consecutive readings.		ACB	
	In the Service Software / Vent Flow & Pressure Diagnosis, increase the Flow Valve counts and view the Flow Valve Current mA and Counts.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
FLOW VERIFICATION FAILURE (dP) CH1		Indicates the commanded flow through the O2 Gas Channel and the flow measured by the Hot-wire anemometer agrees but the flow as measured by the pressure transducers does not agree.		Mixer	
	Perform the Mixer zero. Replace Mixer				
FRONT PANEL COM FAIL	Display panel controls failure	Key pad controller fails to send "life tick" for greater than 10 Sec.	Medium (Yellow)	DC	
	Reboot system. If problem continues, replace Display Controller Board.				
GAS INLET VALVE BOOTUP TEST FAIL	Vent Fail. Monitoring Only	Boot-up test failed.	High	AC, Vent	
	1. Check GIV solenoid connection. 2. Replace GIV. 3. Rebuild the GIV components. 4. Replace VIB.				
INSP FLOW SENSOR CAL ERROR	Calibrate flow sensors	Insp Flow Sensor zero offset out of range.	Low	AC, Vent	Flow sensor detected
	In Service Software, under "Vent Flow and Pressure Diagnostics" (Section 8a.3.2), verify the Inspiratory Pressure counts is 2050 ± 250. Disconnect the Black and White in-line connectors. If the counts return within specified range, check for occlusions in the Bulkhead harness. If the counts do not return within the specified range, replace the VIB.				
INSP FLOW SENSOR EEPROM FAILURE	Replace insp flow sensor	EEPROM cal data read failure	Low	AC, Vent	
	Replace the Inspiratory Flow Sensor.				

<table>
<tr><th>Error Log Entry</th><th>Alarm Text</th><th>Condition (Basic info)</th><th>Priority</th><th>Source</th><th>Enabling Criteria</th></tr>
<tr><th></th><th colspan="5">Action/Troubleshooting</th></tr>
<tr><td rowspan="2">LOSS OF GAS DELIVERY USER SETTINGS

LOSS OF VENT PARAMETER SETTINGS</td><td>Vent Fail. Monitoring Only</td><td>After regular communications has been established between the AC and the Display Computer, this alarm is declared if the system is in the Therapy State and the AC determines the Gas Delivery User Setting (Ventilator Parameter Settings) from the Display Computer arrived more than 10 seconds ago.</td><td></td><td>AC</td><td></td></tr>
<tr><td colspan="5">Reboot system. If problem continues, check the ACB to Mixer communication LED’s (or VIB communication LED’s).
1. If the RCV and XMT (or TXD and RXD) LED’s indicate activity,
• check DU cable connections.
• replace Display Controller board if problem continues.
2. If the RCV and XMT (or TXD and RXD) LED’s indicate no activity,
• check the Anesthesia Control board connection.
• replace the Anesthesia Control board if problem continues.</td></tr>
<tr><td rowspan="2">Low Pressure Leak check failed.</td><td></td><td>Indicates the LowP Leak section of the System Checkout Failed.</td><td></td><td>DU</td><td></td></tr>
<tr><td colspan="5">Troubleshoot the Low Pressure Leak.</td></tr>
<tr><td rowspan="2">Low Pressure Leak check fails.</td><td></td><td>A message or failure displayed during the system checkout.
Low Pressure Leak Check with SCGO failed automated check. Leak measured is greater than 50 ml/min.</td><td></td><td>DU</td><td></td></tr>
<tr><td colspan="5">Check Vaporizer for leaks.
Check integrity of low-pressure circuit (Mixer outlet to SCGO / Insp Flow Sensor).</td></tr>
<tr><td rowspan="2">MANIFOLD PAW SENSOR FAIL</td><td>Vent Fail. Monitoring Only</td><td>Calibration failure at bootup.</td><td>Medium</td><td>AC, Vent</td><td></td></tr>
<tr><td colspan="5">In Service Software, under "Vent Flow and Pressure Diagnostics" (Section 8a.3.2), verify the Manifold Flow counts is 800 ± 250.
Disconnect the White in-line connector in the Manifold Pressure. If the counts return within specified range, check for occlusions in the Bulkhead harness.
If the counts do not return within the specified range, replace the VIB.</td></tr>
</table>

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
MANIFOLD PRESSURE SENSR FAILURE		Indicates a calibration failure at bootup.		ACB	
	In the Service Software / Vent Flow & Pressure Diagnostics, verify the Manifold Flow counts is 800 ± 250. Disconnect the White in-line connector in the Manifold Pressure. If the counts return within specified range, check for occlusions in the Bulkhead harness. If the counts do not return within the specified range, replace the VIB.				
MANIFOLD SENSOR CAL ERROR		Indicates the Manifold Pressure zero failed.		ACB	
	Could be caused by bad span calibration or leaky vent Insp Flow Valve.				
MGAS CHECK SAMPLE GAS OUT >20 SEC	Check sample gas out	MGAS SPEC. Continuous Occlusion Bit set.	Medium	MGAS	MGAS present and MGAS communicates continuous occlusion for 20 seconds
	Replace sample line. See AM TRM for further Troubleshooting.				
MGAS INLET FILTER RESIDUE >40 SEC	Replace D-Fend	MGAS SPEC (Residue build-up on the water trap membrane. This decreases air flow).	Medium	MGAS	MGAS present and MGAS communicates this the Replace Trap alarm bit for 40 seconds
	Replace D-Fend. See AM TRM for further Troubleshooting.				
MGAS LINE BLOCKED >20 SEC	Sample line blocked	MGAS SPEC states The sample tubing inside or outside the monitor blocked, or the water trap is occluded.	Medium	MGAS	MGAS present and MGAS communicates this the continuous occlusion alarm for 20 seconds
	Replace sample line. See AM TRM for further Troubleshooting.				
MGAS SAMPLE LINE NOT CONNECTED >40 S	Check D-Fend	MGAS SPEC states The sample tubing or the D-Fend module is not installed.	Medium	MGAS	MGAS present and MGAS communicates this the OpenGasCircuit alarm for 40 seconds
	Replace D-Fend. See AM TRM for further Troubleshooting.				
MGAS SENSOR INOP > XX	Module fail. No CO_2, AA, O_2 data	MGAS SPEC Mgas communicates hardware failure (RAM failure; ROM checksum error; Error in CPU eeprom; Error O_2 preamp eeprom; Error in SSS board eeprom; Voltage error; Lamp control failure.) or UPI does not initialize.	Medium	MGAS	
	See AM TRM for further Troubleshooting.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
MIXER BAL GAS CHANGE FAIL	Alternate O_2 Screen	Mixer Status Bit: STS__BALGAS_CHANGE_OVER_FAIL After the mixer commanded a change to the balance gas, the status of the selector valve shows the old balance gas is still connected.	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER BALGAS Flow FAIL		Mixer error bit STS_CH2_DELTAP_FLOW_FAIL Pressure difference between P3 and P2 differs from the drop expected at the measured flow for channel 2 (Balance Gas).	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER O2 Flow FAIL	Alternate O_2 Screen	Mixer error bit STS_CH1_DELTAP_FLOW_FAIL Pressure difference differs from the drop expected at the measured flow for Channel 1 (O_2).	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER ACB COM FAIL	Alternate O_2 Screen	Five seconds pass without measured flow data from the mixer.	Medium	AC	Communication has been established between mixer and AC.
	Reboot System. If problem continues, • check/replace Pan Connector to Mixer cable. • replace the Mixer.				
MIXER ACB COM FAILLOST CMD	Alternate O_2 Screen.	Mixer status Bit STS_LOSS_OF_SETFLOW_CMD. Mixer has lost AC flow commands for 5 sec or received “illegal” commands.(hypoxic mix, settings not allowed)	Medium	AC, Mixer	
	Reboot System. If problem continues, • check/replace Pan Connector to Mixer cable. • replace the Mixer.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
MIXER AIR SELECTION VLV FAIL	Alternate O_2 Screen.	Mixer Status Bit: STS_SELV_VAIR_NOTIFY_FAIL The status of the air selector valve does not match the commanded state.	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER BAL GAS F SENSOR FAIL	Alternate O_2 Screen.	Mixer error bit STS_F2_SENSOR_FAIL Balance gas flow sensor failure.	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER BAL GAS TSENSOR FAIL		Mixer error bit STS_T2_SENSOR_FAIL (Balance Gas). Balance gas temperature sensor failure.	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER BAL GAS FLOW CHECK FAIL		Mixer status bit 1LPM_FLOW_TEST_FAIL. Bal gas proportional valve fails flow check STS_FLOW_TEST_BAL_CHAN_FAILshows balance gas proportional valve failed self test.	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER BAL GAS TEMP LIMIT		Mixer error bit STS_CH2_TEMP_LIMIT (Balance Gas). Balance gas temperature exceeds 50 °C.	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER BAL GAS ZERO FAILLEAK		Mixer status bit STS_CH2_ZERO_FLOWPROPN_V_CH2_LEAK_FAIL_TEST_FAIL. Bal gas proportional valve fails zero flow check shows flow while closed.	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER CRC EEPROM FAIL	Alternate O_2 Screen	Runtime CRC check on EEPROM failed. Mixer Status Bit STS_EEPROM_CRC_FAIL.	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
MIXER CRC FLASH FAIL	Alternate O_2 Screen	Runtime CRC check on Flash failed. Mixer Status Bit STS_FLASH_CRC_FAIL	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER CRC RAM FAIL	Alternate O_2 Screen	Runtime CRC walking pattern check on RAM failed. Mixer Status Bit STS_RAMCRC_FAIL.	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER N2O SELECTION VLV FAIL		Mixer Status Bit: STS_SELV_VN2O_NOTIFY_FAIL The status of the N_2O selector valve does not match the commanded state.	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER O2 TSENSOR FAIL	Alternate O_2 Screen.	Mixer error bit STS_T1_SENSOR_FAIL O_2 temperature sensor failure	Medium	AC, Mixer	
	Reboot System. If problem continues, Replace the Mixer.				
MIXER O2 F SENSOR FAIL	Alternate O_2 Screen	Mixer error bit STS_F2F1_SENSOR_FAIL (O_2). O_2 flow sensor fail.	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER O2 FLOW CHECK FAIL	Alternate O_2 Screen	Mixer status bit STS_FLOW_TEST_CH1_FAIL1LPM_FLOW_TEST_FAIL. O_2 proportional valve fails flow check.	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER O2 SELECTION VLV FAIL	Alternate O_2 Screen	Mixer Status Bit: STS_SELV_VOXY_NOTIFY_FAIL The status of the O_2 selector valve does not match the commanded state.	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER O2 TEMP LIMIT	Alternate O_2 Screen	Mixer error bit STS_CH1_TEMP_LIMIT (O_2). O_2 temperature exceeds 50 °C.	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
MIXER O2 ZERO LEAK FAIL		Mixer status bit STS_CH1_ZERO_FLOW_TESPROPN_V_LEAK_FAILT_FAIL. O_2 proportional valve fails zero flow checks for leaks when it should be closed.	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER P SENSOR P2 FAIL		Mixer error bit STS_PRESS_SENSOR_FAIL_P2 Pressure sensor 2 in the mixer has failed.	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER POST FAIL	Alternate O_2 Screen	Mixer tells AC that Power Up Self Test Fail	Medium	AC, Mixer	
	See associated Error in Error Log. i.e. “MIXER O_2 FLOW CHECK FAIL” or “Mix: FLOW VERIFICATION FAILURE (dP) CH1”				
MIXER PRES SENSOR P1P3 FAIL		Mixer error bit STS_PRESS_SENSOR_FAIL_P1P3 One of the pressure sensors in the Mixer has failed (P1 or P3).	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER P SENSOR FAIL		Indicates one of the Mixer Pressure Transducers have failed		Mixer	
	See associated Error in Error Log. i.e. “MIXER P Sensor P2 Fail” or “Mixer Pres Sensor P1P3 Fail”.				
MIXER SW WDOG		Indicates the Mixer Watchdog has been activated.		Mixer	
	See associated Error in Error Log. i.e. “MIXER O2 FLOW CHECK FAIL” or “Mix: FLOW VERIFICATION				
MIXER SW WDOG FAIL	Alternate O_2 Screen	Mixer status Bit STS_SW_WDOG_FAIL.	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER VOLTS FAIL	Alternate O_2 Screen	Mixer power supply (on board) is out of tolerance. Status bit STS_VOLT_REF_FAIL.	Medium	AC, Mixer	+12.5 V (10 VA) to mixer OK.
	In Service Software, under "Mixer Power Diagnostics (Section 8a.1.5), view the “Mixer 10VA Voltage” from Anes Cntrl Bd: If “Mixer 10VA Volts” reads “OK, and +12.5 Vdc reads “Fail”, replace the Mixer. If “Mixer 10VA Volts” reads “Fail”, • check cabling between ACB and Mixer. • replace ACB.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
MIX O2 BYPASS VLV 10VA OVER CURR		Indicates the current feedback from the O2 Bypass Selector was incorrect for seven consecutive readings.		ACB	
	Measure the O2 Bypass Selector Valve. Should be approximately 75 Ω. Replace ACB.				
MODULE NOT COMPATIBLE	Module not compatible	The Monitoring Module detected is not compatible with system software. System is designed to work with the following Compact Airway Module versions: M-CaiO (HW rev 00 and above, SW rev 3.2 and above) and M-CaiOV (HW rev 00 and above, SW Rev 3.2 and above).	Low	DC	
	Replace M-Gas module with compatible module.				
N2O PRESS LOW	N_2O supply pressure low	N_2O pipeline pressure is less than 252 kPa and the N_2O cylinder pressure is less than 2633 kPa.	Low	AC	N_2O is selected as the balance gas with a non zero flow of N_2O
	Check N_2O Supply. Check / Replace N_2O Pipeline/Cylinder Pressure Transducer.				
NO EXPIRATORY FLOW SENSOR	No exp flow sensor	No Expiratory sensor connected and not calibrating	Medium	A, Vent	
	Connect Expiratory flow sensor. Check/Replace Bulkhead harness. Replace VIB Board.				
NO INSPIRATORY FLOW SENSOR	No insp flow sensor	No inspiratory sensor connected and not calibrating.	Medium	AC, Vent	AC -Vent
	Connect Inspiratory flow sensor. Check/Replace Bulkhead harness. Replace VIB Board.				
O2 PROP VALVE FAIL		Mixer status bit STS_CH1_PROPN VALVE FAIL indicates proportional valve failure.	Medium	AC, Mixer	
	Reboot System. If problem continues, Replace the Mixer.				
O2 FLOW CTRL FAIL		Mixer status bit STS_FLOW_CTRL_CH1_FAIL indicates flow control failure.	Medium	AC, Mixer	O_2 gas supply pressure OK
	Reboot System. If problem continues, Replace the Mixer.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
O2 FLUSH FAILURE	O_2 flush stuck on?	Switch is detected “on” continuously > 30 sec.	Low	AC, Vent	
	Alarm condition becomes false for 2 consecutive switch readings.				
O2 PIPE INVALID	Cannot monitor O_2 pipeline	O_2 Pipeline pressure is invalid.	Medium	DC	
	Check O_2 Pipeline Supply. Check / Replace O_2 Pipeline Pressure Transducer				
O2 PRESS LOW	O_2 supply pressure low	O_2 pipeline pressure is less than 252 kPa and the O_2 cylinder has a pressure less than 2633 kPa for one second.	High	AC, DC	N_2O flow stops on threshold detection and Air continues to flow if selected.
	Check O_2 Supply. Check / Replace O_2 Pipeline/Cylinder Pressure Transducer				
O2 SENSOR FAILURE	Replace O_2 sensor	O_2 < 5%	Low	AC, Vent	Galvanic O_2 sensor connected
	Calibrate O_2 Sensor. If calibration fails, replace O_2 Sensor. If calibration continues to fail, wait 90 minutes and repeat calibration. If calibration fails after 90 minute, replace VIB				
O2CAL ERROR	Calibrate O_2 sensor	Offset, slope, or cell voltage not in range or O_2 > 110%	Low	AC, Vent	Galvanic O_2 sensor connected
	Calibrate O_2 Sensor. If calibration fails, replace O_2 Sensor. If calibration continues to fail, wait 90 minutes and repeat calibration. If calibration fails after 90 minute, replace VIB.				
ON/STANDBY SWITCH TO STANDBY	Turn switch on to continue use	On/Standby switch transitions from On to Standby.	High	PC	System state is Therapy and Power Controller is communicating with DC
	No Service Action Required.				
PATIENT VOLUME MISMATCH OCCURRED	Calibrate, dry, or replace flow sensors	PATIENT VOLUME MISMATCH alarm occurred.	Low	AC, Vent, DC checks enable criteria	System state is in Checkout.
	1. Check flow sensor connections. 2. Replace flow sensors. 3. Check the VIB tubing for moisture. 4. Replace VIB.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
PCB Alarm Off: AC Mains failure		Indicates AC Power Removed.		PCB	
	No Service Action Required.				
PCB Alarm Off: DC-DC power module failure		Indicates the AC supply is OK (AC GOOD HIGH) but the system reports using the battery (BATT STAT 1 and 2 LOW).		PCB	
	Check U-frame wiring. Set system switch to Standby; remove mains; wait 20 seconds; power up system. If problem continues, replace PCB.				
PCB Alarm Off: Monitor Current Active w/AC Mains		Indicates the Battery backup current to monitor is active while AC supply is OK.		PCB	
	Check AC power connection to anesthesia monitor and circuit breaker. If problem continues, replace anesthesia monitor.				
PCB Alarm On: 1 min time left		A message or failure displayed during the system checkout.		PCB	
	Leave the system plugged into AC Mains for 24 hours. If issue persists, replace batteries.				
PCB Alarm On: AC mains failure		Indicates AC Power Removed.		PCB	
	No Service Action Required.				
PCB Alarm On: Bulk charge time exceeded in stdby		Indicates the batteries were being Bulk Charged for a period greater than 12 hours while the system was in the Standby state.		PCB	
	Replace Batteries. Replace the Power Controller Board.				
PCB Alarm On: Monitor Current Active w/AC Mains		Indicates the Battery backup current to monitor is active while AC supply is OK.		PCB	
	Check AC power connection to anesthesia monitor and circuit breaker. If problem continues, replace anesthesia monitor.				
PCB Saved Alarm Off: 1 min time left		A message or failure displayed during the system checkout.		PCB	
	Leave the system plugged into AC Mains for 24 hours. If issue persists, replace batteries.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
PCB Saved Alarm Off: AC Mains failure		Indicates AC Power Removed.		PCB	
	No Service Action Required.				
PCB Saved Alarm Off: Blk chrg time exceed in stdby		Indicates the batteries were being Bulk Charged for a period greater than 12 hours while the system was in the Standby state.		PCB	
	Replace Batteries. Replace the Power Controller Board.				
PCB Saved Alarm Off: DC-DC power module failure		Indicates greater than 0.25 amps current draw out of the batteries for 2 minutes while AC Mains is connected to the machine.		PCB	
	Replace Batteries. Replace the Power Controller Board.				
PCB Saved Alarm On: 1 min time left		A message or failure displayed during the system checkout.		PCB	
	Leave the system plugged into AC Mains for 24 hours. If issue persists, replace batteries.				
PCB Saved Alarm On: AC Mains failure		Indicates AC Power Removed.		PCB	
	No Service Action Required.				
PCB Saved Alarm On: DC-DC power module failure		Indicates greater than 0.25 amps current draw out of the batteries for 2 minutes while AC Mains is connected to the machine.		PCB	
	Replace Batteries. Replace the Power Controller Board.				
PCB Saved Alarm On: DU to PSC Comm Error		Indicates a the Power Controller to Display Unit communication was lost. The Power Controller “saved” the error and communicated the error to the Display Unit when communication was next established.		PCB	
	No Service Action Required.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
PCB Saved Error: POWER CNTRL COM FAIL		Indicates communication between the Display Unit computer and the Anesthesia Controller Board (ACB) was lost and a Power Controller error occurred. The error was stored until communication could be re-established and written to the Display Unit computer.		PCB	
	Check the Anesthesia Controller Board (ACB) to Display Unit communication cable.				
PCSELF TEST	Internal failure. System may shut down	PC failed self tests (memory, voltages, or CPU).	High	PC	
	Reboot system. If problem continues, check power supplies in the Service Software. Replace Power Controller Board if continues.				
PEEP PCV NOT AVAILABLE	Vol vent only. No PEEP or PSV	Paw data is in range but the Pmanifold <= -15 cmH_2O	Medium Or Low	DC	None
	Perform flow sensor calibration. If calibration fails, use the Service Application Vent diagnostics to check the transducer precision. Use the Flow valve control to compare linearity of the Manifold transducer to the Paw transducer.				
POWER CONTROLER COM FAIL	Internal failure. System may shut down	Communications with PC and DC cannot be established for ten seconds.	Medium	DC	
	Reboot system. If problem continues: 1. Check DU cable connections. 2. Check the Display Connector board cable connections. 3. Replace the Power Controller board.				
POWER SUPPLY 75C	Circuitry >75C shutdown possible	Power supply temperature exceeds 75C.	Medium	PC	
	Check / Clean cooling fan.				
PRESS SNSOR1 FAILURE		Indicates P1 pressure transducer on the Mixer is out of specification.		Mixer	
	Zero the Mixer pressure transducers. Replace Mixer.				
PWR CNTRL DC-DC FAIL	Using battery. PC fail	AC supply is OK (AC GOOD HIGH) but the system reports using the battery (BATT STAT 1 and 2 LOW).	Medium	PC	
	If applicable, check U-frame wiring. Set system switch to Standby; remove mains; wait 20 seconds; power up system. If problem continues, replace PCB.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
Quick check fails.		A message or failure displayed during the system checkout.		DU	
	Check for other errors in the error logs.				
REVERSE EXPIRATORY FLOW	Reverse exp flow. Check valves OK?	Flow towards the patient (volume >= 20 mL) on expiratory sensor and flow towards the patient (volume >= 5 mL) on the inspiratory sensor during inspiration for 6 consecutive mechanical breaths.	Medium	AC Vent	In-range flow data available, mechanical ventilation on
	Check flow sensor connections for "No Flow Sensor" alarm. Check the breathing circuit. Perform flow sensor calibration. Check Insp/Exp check valves. Replace the flow sensors. Check for kinked VIB tubing. Check the VIB cabling.				
SCGO	Vol and Apnea monitoring off	Non Circle SCGO selected.	Low	DC	System has SCGO
	No service action required.				
SEVERE SUSTAINED PAW		Indicates the measures airway pressure was greater than 100 cm H2O for 10 seconds.		ACB	
	No Service Action. Reboot system. If problem continues, check Airway Pressure signal in Service Mode.				
STANDBY PATIENT DETECTION	No fresh gas flow!	3 volume breaths are detected within 30 seconds or 3 CO_2 breaths are detected within 30 seconds	High	DC	System in Checkout: General or Checkout: Start Case
	No service action required.				
System Self-tests failed		Indicates the Power-on tests failed. Look for other entries for clarification.		DU	
	Check for other errors in the error logs (Compatibility failure, Compatibility incomplete, etc.).				
VALVE CH1 LEAK TESTS NOT DONE		Indicates the O2 Leak Test skipped. Can be caused by no O2 supply connected at power-up.		Mixer	
	No Service Action Required.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
VAP-MIXER FAN FAIL	Cooling fan needs service. System OK	Fan current < 0.09 Amps > 0.25 Amps	Medium	Mixer	Communication between Display Computer - ACB and ACB - Mixer.
	Connect rear panel fan. Replace rear panel fan. Replace Mixer if no voltage.				
Vent check stage 1 failed.		A message or failure displayed during the system checkout.		DU	
	Checkout failed. Check for other errors in the error logs.				
Vent check stage 1 fails.		A message or failure displayed during the system checkout.		DU	
	Checkout failed.Check for other errors in the error logs.				
Vent check stage 2 failed.		A message or failure displayed during the system checkout.		DU	
	Checkout failed.Check for other errors in the error logs.				
Vent check stage 2 fails.		A message or failure displayed during the system checkout.		DU	
	Checkout failed. Check for other errors in the error logs.				
VENT FLOW VALVE FAIL DAC	Vent Fail. Monitoring Only	Incorrect DAC feedback for 3 consecutive readings	Medium	AC, Vent	
	Reboot System. If problem continues, in the Service Software / Vent Flow & Pressure Diagnosis, increase the Flow Valve counts and view the Flow Valve Feedback mV and Counts. Verify the settings match.				
VENT +12.5V FAIL	Vent Fail. Monitoring Only	Nominal 12.5V <11.3 Vdc or >13.13 Vdc	Medium	AC, Vent	
	In Service Software, under "Vent Interface Bd Power Diagnostics" (Section 8a.1.6), view the “Vent Int Bd 10VA Voltage” from Board Supplies: If “Vent Int Bd 10VA Voltage” reads “OK, and +12.5 Vdc reads “Fail”, replace the VIB. If “Vent Int Bd 10VA Voltage” reads “Fail” and the “Vent Int Bd 10VA Voltage” from the Anes Cntrl Bd reads “OK”, Check cabling between ACB and VIB.				
VENT +6V FAIL	Vent Fail. Monitoring Only	VSIB +6V out of range<5.51 Vdc or > 6.5 Vdc	High	AC, Vent	Vent +12.5 V (10 VA) is OK
	In Service Software, under "Vent Interface Bd Power Diagnostics" (Section 8a.1.6), view the “Vent Int Bd 10VA Voltage” from Board Supplies: If “Vent Int Bd 10VA Voltage” reads “OK, and +6.0Vdc reads “Fail”, replace the VIB. If “Vent Int Bd 10VA Voltage” reads “Fail” and the “Vent Int Bd 10VA Voltage” from the Anes Cntrl Bd reads “OK”, Check cabling between ACB and VIB.				

<table>
<tr><th rowspan="2">Error Log Entry</th><th>Alarm Text</th><th>Condition (Basic info)</th><th>Priority</th><th>Source</th><th>Enabling Criteria</th></tr>
<tr><th colspan="5">Action/Troubleshooting</th></tr>
<tr><td rowspan="2">VENT 1.22V FAIL</td><td>Vent Fail. Monitoring Only</td><td>Voltage < 1.074Vdc or Voltage > 1.367 Vdc</td><td>Medium</td><td>AC, Vent</td><td>Vent +12.5 V (10 VA) is OK</td></tr>
<tr><td colspan="5">In Service Software, under "Vent Interface Bd Power Diagnostics" (Section 8a.1.6), view the “Vent Int Bd 10VA Voltage” from Board Supplies:
If “Vent Int Bd 10VA Voltage” reads “OK, and 1.22 Vdc reads “Fail”, replace the VIB.
If “Vent Int Bd 10VA Voltage” reads “Fail” and the “Vent Int Bd 10VA Voltage” from the Anes Cntrl Bd reads “OK”, Check cabling between ACB and VIB</td></tr>
<tr><td rowspan="2">VENT -6V FAIL</td><td>Vent Fail. Monitoring Only</td><td>VSIB -6V out of range<-6.72 Vdc or > -5.28 Vdc</td><td>High</td><td>AC, Vent</td><td>Vent +12.5 V (10 VA) is OK</td></tr>
<tr><td colspan="5">In Service Software, under "Vent Interface Bd Power Diagnostics" (Section 8a.1.6), view the “Vent Int Bd 10VA Voltage” from Board Supplies:
If “Vent Int Bd 10VA Voltage” reads “OK, and -6.0Vdc reads “Fail”, replace the VIB.
If “Vent Int Bd 10VA Voltage” reads “Fail” and the “Vent Int Bd 10VA Voltage” from the Anes Cntrl Bd reads “OK”, Check cabling between ACB and VIB.</td></tr>
<tr><td rowspan="2">VENT ADC VREF FAIL</td><td>Vent Fail. Monitoring Only</td><td>VSIB ADC3.200V ref voltage out of range <3.179 or >3.221 Vdc</td><td>High</td><td>AC, Vent</td><td>Vent +12.5 V (10 VA) is OK</td></tr>
<tr><td colspan="5">In Service Software, under "Vent Interface Bd Power Diagnostics" (Section 8a.1.6), view the “Vent Int Bd 10VA Voltage” from Board Supplies:
If “Vent Int Bd 10VA Voltage” reads “OK, and 3.2 Vdc reads “Fail”, replace the VIB.
If “Vent Int Bd 10VA Voltage” reads “Fail” and the “Vent Int Bd 10VA Voltage” from the Anes Cntrl Bd reads “OK”, Check cabling between ACB and VIB.</td></tr>
<tr><td rowspan="2">VENT AIRWAY OVERPRESS SIGNAL</td><td>Inspiration stopped</td><td>High airway overpressure signal set.</td><td>Medium</td><td>AC, Vent</td><td>Mechanical Ventilation On</td></tr>
<tr><td colspan="5">No Service Action.
Reboot system. If problem continues, check Airway Pressure signal in Service Mode.</td></tr>
<tr><td rowspan="2">VENT AIRWAY OVERPRESS SIGNAL FAIL</td><td>Vent Fail. Monitoring Only</td><td>Ventilator SIB indicates the High Airway overpressure signal was set and Paw < 90 cmH_2O and Pmanifold <80 cm H_2O.</td><td>Medium</td><td>AC, Vent</td><td>Mechanical Ventilation On</td></tr>
<tr><td colspan="5">No Service Action.
Reboot system. If problem continues, check Airway Pressure signal in Service Mode.</td></tr>
<tr><td rowspan="2">VENT FLOW VALVE FAIL CURRENT</td><td>Vent Fail. Monitoring Only</td><td>Incorrect current feedback for 7 consecutive readings.</td><td>Medium</td><td>AC, Vent</td><td></td></tr>
<tr><td colspan="5">Reboot System.
If problem continues, in Service Software, under "Vent Interface Bd Power Diagnostics" (Section 8a.1.6), increase the Flow Valve counts and view the Flow Valve Current mA and Counts.</td></tr>
<tr><td rowspan="2">VENT SIB 10VA OVER CURRENT</td><td></td><td>Indicates the current feedback from the VIB was incorrect.</td><td></td><td>ACB</td><td></td></tr>
<tr><td colspan="5">Disconnect VIB power harness and restart the system.
If the error does not reappear in the log,
• replace the VIB and retest.
If the error persists,
• replace the ACB.</td></tr>
</table>

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
VENT SIB COMMUNICATION FAILURE		Indicates a loss of communication between the Anesthesia Controller Board (ACB) and the Ventilator Interface Board (VIB) after communication has been established.		ACB	
	Check cabling. Replace Pan Connector Board. Replace VIB. Replace ACB.				
VENT SUSTAINED PAW SDOWN	Vent Fail. Monitoring Only	Paw > 100 cmH_2O for 10 seconds.	Medium	AC, Vent	In-range Paw data available
	No Service Action. Reboot system. If problem continues, check Airway Pressure signal in Service Mode.				
VENT VALVE 10VA OVER CURRENT		Indicates the current feedback from the Insp Flow Valve was incorrect for seven consecutive readings.		ACB	
	In the Service Software / Vent Flow & Pressure Diagnosis, increase the Flow Valve counts and view the Flow Valve Current mA and Counts.				
VENT VALVE POWER FAIL	Vent Fail. Monitoring Only	Nominal 12.5V <11.3 V or >13.13Vdc	Medium	AC, Vent	
	In Service Software, under "Vent Interface Bd Power Diagnostics" (Section 8a.1.6), view the “Vent Int Bd 10VA Voltage” from Board Supplies: If “Vent Int Bd 10VA Voltage” reads “OK, and the Vent Valve 10VA Volts reads “Fail”, disconnect the VIB to Pan connector harness. If the Vent Valve 10VA Volts continues to read “Fail”, replace the VIB. If “Vent Int Bd 10VA Voltage” reads “Fail” and the “Vent Int Bd 10VA Voltage” from the Anes Cntrl Bd reads “OK”, Check cabling between ACB and VIB.				
VLV BAL GAS CH LEAK TESTS NOT DONE		Indicates the Bal Gas Leak Test skipped. Can be caused by no Bal Gas connected at power-up.		Mixer	
	No Service Action Required.				

7.11 Steps and Messages displayed during the System Checkout — (for System software 3.X or greater)

Stage 1: Step 1: "Bag/Vent Switch" - Verify the Bag/Vent Switch is set correctly.

- If the switch is set to Ventilator Mode continue with next step
- If the switch is set to Manual Mode, fail with "Wrong circuit selected".

Step 2: "O2 Pressure" - Is O_2 available and working.

- If O_2 Supply is adequate and mixer passes a mixer flow test of 250 ml/min of O_2 continue with the next step.
- If not fail with "Low O2 supply pressure" or with mixer failure.

Step 3: "Ventilator Drive Pressure" - Make sure ventilator has drive gas pressure:

- If drive gas pressure (as measured by the Manifold Pressure Transducer) continue with the next step.
- If no drive gas pressure, fail with "Ventilator has no drive gas".
- If all of the steps above pass, the ventilator will be commanded to flow 12 L/min (Software less than 3.20) or 18 L/min (Software equal to or greater than 3.20). Before selecting "Continue" on the next menu, "Make sure the bellows are fully collapsed" before you "Occlude the Patient Y".

Stage 2: Step 1: "Verify the Bellows Empty" - Check to make sure bellows is collapsed.

- If Airway pressure increases to or above 30 cm H_20 in 5 seconds fail the test with, "Can not empty bellows".
- If not continue with next step.

Step 2: "Circuit Leak Test" - Attempt to find the leak of the ventilator mode system.

If the **Leak < 250 ml** is set to **No**:

- Flow 1 l/min O2 until pressure increases to 20 cm H_20.
- If pressure does not increase to 20 cm H_20 within in 15 seconds, fail with "Cannot pressurize circuit". If it does reach 20 cm H_20, change flow to 250 ml/min.
- If a flow of 250 ml/min reaches 30 cm H_20 or greater, display "Circuit leak is less than 250 ml/min" and continue to next step. If it does not, increase flow up to 750 ml/min.
- If a flow of 750 ml/min that reaches 30 cm H_20, continue to next step but indicate the "Ventilator circuit leak is between 250 ml/min and 750 ml/min".
- If the circuit pressure does not increase to 30 cm H2O with 750 ml/min flow, fail with "Ventilator circuit leak is greater than 750 ml/min".

If the **Leak < 250 ml** is set to **Yes**:

- Flow 1 l/min O2 until pressure increases to 20 cm H_20.
- If pressure does not increase to 20 cm H_20 within in 15 seconds, fail with "Cannot pressurize circuit". If it does reach 20 cm H_20, change flow to 100 ml/min.

- If a flow of 100 ml/min reaches 30 cm H_2O or greater, display “Circuit leak is less than 100 ml/min” and continue to next step. If it does not, gradually increase flow until pressure reaches 30 cm H_2O.
- If a flow is found that reaches 30 cm H20 and that flow is less than 750 ml/ min continue to next step but indicate that, “Ventilator circuit leak is ## ml/ min”.
- If the circuit pressure does not increase to 30 cm H2O with 750 ml/min flow, fail with “Ventilator circuit leak is greater than 750 ml/min”.

Step 3: “Mechanical Ventilation” - Tests the Mechanical Ventilation by delivering small Pressure Controlled breaths and look for alarms:

- If alarm condition is detected it will be stated in final menu.
- Continue to next step.

Step 4: “Circuit Compliance” - Tests the circuit compliance by delivering small (15 cm H_2O) Pressure Controlled breaths, measures the circuit volume via the expiratory flow sensor, and looks for alarms:

- If the measured volume is less than 15 ml (either due to small patient circuit or flow sensor issues) a “Check Flow Sensor” alarm may be generated that prohibit the calculation of circuit compliance, state that “Can not measure circuit compliance”.
- If alarms did not occur then calculate compliance and state, “Circuit Compliance YYY ml/ cm H20”

Step 5: “O_2 Flow” - Run the mixer tests on O_2 channel (Check gas supply and run a 3L and 10L flow delivery test and leak test:

- If O2 pressure is low, fail with “Low O2 Supply pressure”.
- If mixer does not fail the 3L, 10L and the leak test, continue with the next step.
- If mixer fails the 3L, 10L or the leak test, fail with the mixer failure.

Step 6: “AIR Flow” – Run the mixer tests on AIR channel (Check gas supply and run a 3L and 10L flow delivery test and leak test:

- If O2 is drive gas and air supply is low, continue with next step and indicate, “Could not test air”.
- If Air is the drive gas and air supply is low, continue with next step and indicate, “Ventilator has not drive gas”.
- If mixer does not fail the 3L,10L and the leak test, continue with the next step.
- If mixer fails the 3L,10L or the leak test, fail with the mixer failure.

Step 7: “N_2O Flow” – Run the mixer tests on N_2O channel (Check gas supply and run a 3L and 10L flow delivery test and leak test:

- If N_2O is disabled, continue with next step.
- If N_2O supply is low, continue with next step and indicate, “Could not test N_2O”.
- If mixer does not fail the 3L,10L and the leak test, continue with the next step.
- If mixer fails the 3L,10L or the leak test, fail with the mixer failure.

Step 8: "Battery and Electrical" – Are the AC/Mains connected and the battery charged?

- If AC/Mains failed indicate, "Power cord disconnected. Using battery".
- If Battery failed indicate, "Battery failure".
- If Battery charging with 20 - 30 minutes available indicate, "Battery still charging."
- If Battery charging with 10 - 20 minutes available indicate, "Battery still charging".
- If battery charging with 0-10 minutes available indicate, "Battery still charging".
- If battery fully charged, pass step.

7.12 Steps and Messages displayed during the System Checkout — (for System software 2.X)

7.12.1 Steps for the Quick Check

Step1: Check to make sure bag/vent switch is set correctly.

- If switch is set to manual mode continue with the next step.
- If set to ventilator mode fail with, "Wrong circuit selected".

Step2: Is O_2 available and working?

- If O_2 Supply is Not low and mixer passes a mixer flow test of 250 ml/min of O_2 continue with the next step.
- If not fail with "Low O_2 supply pressure" or with mixer failure.

Step3: Is circuit (airway) pressure too high?

- Check the circuit (airway) pressure is less than 30 cm H_20; continue with the next step.
- If airway pressure greater than 30 cm H_20 fail with "Circuit pressure too high".
- Step4: Find manual circuit leak:
- Increase flow to find the manual circuit leak.
- If pressure does not increase to 30 cm H_20 fail with "Cannot pressurize circuit".
- If flow required to maintain pressure at 30 cm H_20 is greater than 250 ml/min state "Manual circuit leak is XXX ml/min at 30 cm H_20".
- If flow required to maintain pressure at 30 cm H_20 is less than or equal to 250 cm H_20 continue with the next step.

Step 5: Run mixer tests on the O_2 channel (check supply and run a 3L, 10L and leak test):

- If O_2 pressure is low, fail with "Low O_2 Supply pressure".
- If mixer does not fail the 3L,10L and the leak test, continue with the next step.
- If mixer fails the 3L,10L or the leak test, fail with the mixer failure.

Step 6: Run mixer tests on the Air channel (check supply and run a 3L, 10L and leak test):

- If O_2 is drive gas and air supply is low, continue with next step and indicate, “Could not test air”.
- If Air is the drive gas and air supply is low, continue with next step and indicate, “Ventilator has not drive gas”.
- If mixer does not fail the 3L,10L and the leak test, continue with the next step. If mixer fails the 3L,10L or the leak test, fail with the mixer failure.

Step 7: Run mixer tests on the N_2O channel (check supply and run a 3L, 10L and leak test):

- If N_2O is disabled, continue with next step.
- If N_2O supply is low, continue with next step and indicate, “Could not test N_2O”.
- If mixer does not fail the 3L,10L and the leak test, continue with the next step.
- If mixer fails the 3L,10L or the leak test, fail with the mixer failure.

Step 8: Are the AC/Mains connected and the battery charged?

- If AC/Mains failed indicate, “Power cord disconnected. Using battery”.
- If Battery failed indicate, “Battery failure”.
- If Battery charging with 20 - 30 minutes available indicate, “Battery still charging.”
- If Battery charging with 10 - 20 minutes available indicate, “Battery still charging”.
- If battery charging with 0-10 minutes available indicate, “Battery still charging”.
- If battery fully charged, pass step.

7.12.2 Steps for the Vent Check

Stage 1:

Step 1: Check to make sure bag/vent switch is set correctly.

- If switch is set to ventilator continue with the next step.
- If set to manual mode fail with “Wrong Circuit Selected”.

Step 2: Is O_2 Pressure Not Low?

- If O_2 Supply is Not low and mixer passes it's 3 L test continue to next step.
- If not fail with “Low O_2 supply pressure” or with mixer failure.

Step 3: Make sure ventilator has drive gas pressure:

- If drive gas pressure continue with the next step.
- If no drive gas pressure, fail with “Ventilator has no drive gas”.
- If all of the steps above pass, the ventilator will be commanded to flow 12 L/min. Depending on the software you have a 10 second delay may be in place before the next menu is displayed. Either way before selecting “Continue” on the next menu, “Make sure the bellows are fully collapsed” before you “Occlude the Patient Y”.

Stage 2:

Step 1: Check to make sure bellows are collapsed.

- If Airway pressure increases to or above 30 cm H_20 in 5 seconds fail the test with, “Can not empty bellows”.
- If not continue with next step.

Step 2: Attempt to find the leak of the ventilator mode system.

- Flow 1 l/min O_2 until pressure increases to 20 cm H_20.
- If pressure does not increase to 20 cm H_20 within in 15 seconds, fail with “Cannot pressurize circuit”. If it does reach 20 cm H_20, change flow to 250 ml/min.
- If a flow of 250 ml/min reaches 30 cm H_20 or greater continue to next step. If it does not, increase flow up to 750 ml/min.
- If a flow is found that reaches 30 cm H_20 and that flow is less than 750 ml/min continue to next step but indicate that, “Ventilator circuit leak is ## ml/min”.
- If a flow greater than 750 ml/min is required, fail with, “Ventilator circuit leak is greater than 750 ml/min”.

Step 3: System delivers small breaths and looks for alarms using default alarm limits.

- If alarm condition is detected it will be stated in final menu.
- Continue to next step.

Step 4: Calculate circuit compliance.

- If alarms occurred that prohibit the calculation of circuit compliance, state that “Can not measure circuit compliance”.
- If alarms did not occur then calculate compliance and state, “Circuit Compliance YYY ml/ cm H_20”

Notes

8a Service Diagnostics and Software Download (DU)

In this section

8a.1 Avance Service Application

This section documents the Avance Service Application that loads from a PCMCIA card and is used to download software or to run various diagnostic functions.

To run the application, first set the system switch to Standby and set the AC Inlet power switch to Off. Insert the card carrier (with card facing to the rear) into the rear PCMCIA interface slot of the display unit (behind left side door), then set the AC Inlet power switch and the system switch to On. The service application will load and display the Main Menu along with the System Information page.

8a.1.1 Main Menu and System Information

The Main Menu appears on the left-hand side of the screen and includes the following selections as shown in the table below:

Main Menu	Remarks
Power Diagnostics	Access to the Power Supply Diagnostics functions
Gas Diagnostics	Access to the Gas Delivery Diagnostics functions
Vent Diagnostics	Access to the Ventilator Diagnostics functions
Display Diagnostics	Access to the Front Panel Controls
Special Functions	Access to logs from the Display Unit

Software Download	Access to the Software Download function.

Note You can not return to the Diagnostic section of the service application after entering the software download section. You must reboot the system to exit Software Download.

The System Information page appears on the right-hand side of the screen and displays the following system information as shown in the table below:

System Information

Subsystem	HW Rev	Serial #	SW Ver #	Boot
Front Panel Cntl	- - -	- - -	XX.XX	
Power Controller	XXX/A/XXX	ABCXXXXX	XX.XX	XX.XX
Electronic Mixer	XXX/A/XXX	ABCXXXXX	XX.XX	XX.XX
Vent Intface Bd	XXX/A/XXX	ABCXXXXX	XX.XX	XX.XX
Anes Control Bd	XXX/A/XXX	ABCXXXXX	XX.XX	XX.XX
Dsply Unit BIOS	XXX/A/XXX	ABCXXXXX	XX.XX	
Dsply Unit App	XXX/A/XXX	ABCXXXXX	XX.XX	
Machine Serial Number: ABCDXXXXX				
PC Card ID: XXXX_XX				

8a.1.2 Power Diagnostics

The service application provides power supply diagnostics for the various circuit boards in the Avance anesthesia machine.

Selecting ***Power Diagnostics*** on the Main Menu brings up the following menu selections in the left-hand frame and the instructions in the right-hand frame:

Main Menu
Power Diagnostics
Gas Diagnostics
Vent Diagnostics
Display Diagnostics
Special Functions

Software Download

Power Diagnostics	Power Controller Power Diagnostics
Power Control Anes Control Board Mixer Vent Interface Bd Display Unit -> Main Menu	Select a menu item to see the power status and measured voltages. To troubleshoot a power problem, start with the power controller and work forward. Problem voltages are in red.

8a.1.3 Power Controller Power Diagnostics

There are two pages of diagnostics for the Power Controller.

Selecting ***Power Control*** brings up the first page of the Power Controller Diagnostics.

Power Diagnostics
Power Control
Anes Control Board
Mixer
Vent Interface Bd
Display Unit
->Main Menu

(Page 1 of 2)
Power Control Power Diagnostics

Label	Value Format	Units	Normal range
AC Status	OK, Fail		
12Vdc Supply	XX.XX	Vdc	11.82 to 12.18
3.3Vdc Supply	X.XXX	Vdc	3.201 to 3.399
1.5 Vdc Supply	X.XXX	Vdc	1.45 to 1.55
Battery Connected	Yes, No		
Battery Status	Fail, Bulk Chg, Over Chg, Float Chg, Trickle Chg, Discharge		
Battery Current	X.XXX	A	
Calc Battery Time	XX	Min	0 to 30
Battery 1 Volts	XX.X < 6.0 FAIL (red) <10 T Chg (yellow) 10-15.5 (Green)	Vdc	10.0 to 15.5
Battery 2 Volts	XX.X < 6.0 FAIL (red) <10 T Chg (yellow) 10-15.5 (Green)	Vdc	10.0 to 15.5
Date battery Tested (*)	XX-ABC-XXXX		
Last Full Discharge Time (*)	XX	Min	

Turn the ComWheel to select the second page.

Push the ComWheel to return focus to the Power Diagnostics selection menu.

(*) These entries are only listed after a full discharge test of the batteries is first performed (Section 6.10, "*Battery capacity test*").

Power Diagnostics
Power Control
Anes Control Board
Mixer
Vent Interface Bd
Display Unit
->Main Menu

(Page 2 of 2)
Power Control Power Diagnostics

Label	**Value Format**	**Units**	**Normal range**
Board Temperature	<65C OK (green) >65C <75C Warn (Yellow) >75C Fail (red)	Deg C	Upper 64
Fan Speed	Slow, Fast		
Fan 1 Voltage	XX.XX	Vdc	11.52 to 12.48
Fan 1 Status	Low, High, Fail, OK		

Turn the ComWheel to return to the first page.

Push the ComWheel to return focus to the Power Diagnostics selection menu.

8a.1.4 Anesthesia Control Board Power Diagnostics

There are two pages of diagnostics for the Anesthesia Control board.

Selecting ***Anes Control Board*** brings up the first page of the Anesthesia Control Board Power Diagnostics.

Power Diagnostics
Power Control
Anes Control Board
Mixer
Vent Interface Bd
Display Unit
->Main Menu

(Page 1 of 2)
Anes Control Board Power Diagnostics

Label	Value Format	Units	Normal range
12.5Vdc from Pwr Cntrl	XX.XX	Vdc	11.90 to 12.90
ADC Reference	X.XXX	Vdc	4.018 to 4.176
Gas Select 10VA Volts	OK, Fail		
Gas Select 10VA Amps	OK, Fail		
P Xducer 10VA Amps	OK, Fail		
Vent Int Bd 10VA Volts	OK, Fail		
Vent Int Bd 10VA Amps	OK, Fail		
Vent Valves 10VA Volts	OK, Fail		
Vent Valves 10VA Amps	OK, Fail		
Acces 1 10VA Volts	OK, Fail		
Acces 1 10VA Amps	OK, Fail		

Turn the ComWheel to select the second page.

Push the ComWheel to return focus to the Power Diagnostics selection menu.

Power Diagnostics
Power Control
Anes Control Board
Mixer
Vent Interface Bd
Display Unit
->Main Menu

(Page 2 of 2)
Anes Control Board Power Diagnostics

Label	Value Format
Gas Unit 10VA Volts	OK, Fail
Gas Unit 10VA Amps	OK, Fail
Mixer 10VA Volts	OK, Fail
Mixer 10VA Amps	OK, Fail
Alt O2 10VA Volts	OK, Fail
Alt O2 10VA Amps	OK, Fail
Periph1 10VA Volts	OK, Fail
Periph1 10VA Amps	OK, Fail
Periph2 10VA Volts	OK, Fail
Periph2 10VA Amps	OK, Fail

Turn the ComWheel to return to the first page.

Push the ComWheel to return focus to the Power Diagnostics selection menu.

8a.1.5 Electronic Mixer Power Diagnostics

Selecting ***Mixer*** brings up the Electronic Mixer Power Diagnostics page.

Power Diagnostics
Power Control
Anes Control Board
Mixer
Vent Interface Bd
Display Unit
->Main Menu

Mixer Power Diagnostics

Label	Value Format	Units	Normal range
From Anes Cntrl Bd			
Mixer 10VA Volts	OK, Fail		
Board Supplies			
12.5 V	XX.XX	Vdc	11.80 to 13.00
5.5V	X.XX	Vdc	5.39 to 5.61
3.3V CPU	X.XX	Vdc	3.22 to 3.38
2.5V ADC Ref	X.XX	Vdc	2.47 to 2.53

8a.1.6 Ventilator Interface Board Power Diagnostics

Selecting ***Vent Interface Board*** brings up the Ventilator Interface Board Power Diagnostics page.

Power Diagnostics
Power Control
Anes Control Board
Mixer
Vent Interface Bd
Display Unit
->Main Menu

Vent Interface Bd Power Diagnostics

Label	**Value Format**	**Units**	**Normal range**
From Anes Cntrl Bd			
Vent Int Bd 10VA Volts	OK, Fail		
Vent Valves 10VA Volts	OK, Fail		
Board Supplies			
Vent Int Bd 10VA Volts	XX.XX	Vdc	11.30 to13.13
Vent Valves 10VA Volts	XX.XX	Vdc	11.30 to13.13
3.2Vdc (12bit Vref)	X.XXX XXXX	Vdc Counts	3.179 to 3.221
1.22Vdc (10bit Vref)	X.XXX XXXX	Vdc Counts	1.074 to 1.367
+6.0Vdc	X.XX	Vdc	5.51 to 6.50
-6.0Vdc	-X.XX	Vdc	-6.72 to -5.28

8a.1.7 Display Unit Power Diagnostics

Selecting ***Display Unit*** brings up the Display Unit Power Diagnostics page.

Power Diagnostics
Power Control
Anes Control Board
Mixer
Vent Interface Bd
Display Unit
->Main Menu

Display Unit Power Diagnostics

Label	Value Format	Units	Normal range
5.0Vdc (PCMCIA)	X.XX	Vdc	4.50 to 5.50
3.3Vdc (PCMCIA)	X.XX	Vdc	2.97 to 3.63
5.0Vdc (Fan)	X.XX	Vdc	4.50 to 5.50
5.0Vdc (USB)	X.XX	Vdc	4.50 to 5.50
8.0Vdc (DIS)	X.XX	Vdc	7.20 to 8.80
11Vdc (LCD)	XX.XX	Vdc	10.35 to 13.62

8a.2 Gas Diagnostics

Selecting ***Gas Diagnostics*** on the Main Menu brings up the following menu selections in the left-hand frame and the instructions in the right-hand frame.

Main Menu
Power Diagnostics
Gas Diagnostics
Vent Diagnostics
Display Diagnostics

Software Download

Gas Diagnostics	**Gas Diagnostics**
Gas Supplies Mixer Output Mixer Tests and Pres Mixer Temperatures O2 Flow: OFF N2O Flow: OFF Air Flow OFF Breathing Sys Leak -> Main Menu	To troubleshoot a problem with gas supplies or gas flows, start with the gas supplies menu and work forward. To turn on gas flows, select O2, N2O, or Air in the left menu. Available flows are: 100% O2: 0.2, 0.5, 5, 10 l/min 100% N2O: 0.2, 0.5, 5, 10 l/min Air: 0.2, 0.5, 5, 10 l/min Turning ON a different gas automatically turns OFF previous flows. All gas flows stop if you go back to the main menu.

Selecting any of the first four items in the left-hand frame, brings up the corresponding diagnostic page in the right-hand frame.

Press the ComWheel to return focus to the right-hand frame to make another selection.

Start gas flow

Selecting one of the three gas flows brings up a page on which you can set one of the four flow values for the selected gas:

- 0.2 l/min; 0.5 l/min, 5.0 l/min, 10.0 l/min.

Press the ComWheel to start the selected flow.

Press the ComWheel again to return to the flow page to observe the Airway Pressure reading. Or select one of the four diagnostics pages to view the displayed conditions.

Selecting Breathing Sys Leak, opens the GIV valve and sets a flow through the inspiratory flow valve. While on the Breathing Sys Leak page, you can set O2 flow to the breathing system and observe the Airway Pressure reading.

Stop gas flow

Gas will continue to flow at the set rate until you:

- set a different flow for the same gas,
- set a flow for a different gas (automatically turns the previous gas flow OFF),
- set the current gas flow to OFF (all flows OFF),
- exit Gas Diagnostics to the Main Menu.

8a.2.1 Gas Supplies

Each gas supply shows the derived pressure in kPa and psi along with the raw voltage from the pressure transducer.

If a supply module for a gas is not installed, or if the transducer is disconnected, the supply shows 0.00 Vdc.

If a supply module is installed but no supply is connected, the supply shows approximately 0.50 Vdc.

The remaining items show the state of the Electronic Mixer selector valves.

Gas Diagnostics
Gas Supplies
Mixer Output
Mixer Tests and Pres
Mixer Temperatures
O2 Flow: 0.5
N2O Flow: OFF
Air Flow: OFF
Breathing Sys Leak
-> Main Menu

Gas Supplies Gas Diagnostics

Label	psi	kPa	Vdc
O2 Cylinder 1	XXXX	XXXXX	XX.XXX
O2 Cylinder 2	XXXX	XXXXX	XX.XXX
Air Cylinder	XXXX	XXXXX	XX.XXX
N2O Cylinder	XXXX	XXXXX	XX.XXX
O2 Pipeline	XXXX	XXXXX	XX.XXX
Air Pipeline	XXXX	XXXXX	XX.XXX
N2O Pipeline	XXXX	XXXXX	XX.XXX
O2 Select Valve	Open	Flow command ON	
N2O Select Valve	Closed	Flow command OFF	
Air Select Valve	Closed	Flow command OFF	
Alt O2 Valve	Closed		
Note: 0.0 Vdc = not installed or transducer disconnected.			

8a.2.2 Mixer Output

Selecting ***Mixer Output*** brings up the Mixer Output Gas Diagnostics page.

This data comes from the Anesthesia Control board. The Flow Verify signals are rough calculations of the mixer flow based on pressure drop and temperature. The ADC reference voltage is used to convert flow signals.

Gas Diagnostics
Gas Supplies
Mixer Output
Mixer Tests and Pres
Mixer Temperatures
O2 Flow: 0.5
N2O Flow: OFF
Air Flow: OFF
Breathing Sys Leak
-> Main Menu

Mixer Output Gas Diagnostics

Label	Value	Units
O2 Flow	XX.XX	l/min
Balance Flow	XX.XX	l/min
O2 Flow Verify	XX.XX	l/min
O2 Flow Signal	X.XXX	Vdc
O2 Prop Valve Drive	XXXX	mA
Balance Gas ID	None, Air, N2O	
Balance Flow Verify	XX.XX	l/min
Balance Flow Signal	X.XXX	Vdc
Balance Prop Valve Drive	XXXX	mA
O2 Select Valve	Open	
Air Select Valve	Closed	
N2O Select Valve	Closed	
ADC Ref Voltage	X.XXX	Vdc

8a.2.3 Mixer Tests and Pressure

Selecting ***Mixer Tests and Pres*** brings up the Mixer Tests and Pres Gas Delivery Diagnostics page.

Gas Diagnostics
Gas Supplies
Mixer Output
Mixer Tests and Pres
Mixer Temperatures
O2 Flow: 0.5
N2O Flow: OFF
Air Flow: OFF
Breathing Sys Leak
-> Main Menu

Mixer Tests and Pres Gas Diagnostics

Last Power-Up Tests			
O2 Proportional Valve Leak	Not done. No supply pressure Not done. Selector valve incorrect state Pass Fail. Selector valve leaks Fail. Proportional valve leaks		
Alt O2 Valve Leak	Pass; Fail		
Balance Gas Prop Valve Leak	Not done. No supply pressure Not done. Selector valve incorrect state Pass Fail. Selector valve leaks Fail. Proportional valve leaks		
Balance Gas CheckValve Leak	Pass; Fail		
O2 Flow Test	Not done. No supply pressure; Not done. Selector valve incorrect state; Pass; Fail, 3 l/min test; Fail, 10 l/min test		
Balance Flow Test	Not done. No supply pressure; Not done. Selector valve incorrect state; Pass; Fail, 3 l/min test; Fail, 10 l/min test		
Balance Gas ID	None; Air; N2O		
Pressure Data	**Value**	**Units**	**kPa**
O2 Pressure (P1)	XX.XX	psi	XXX.XX
O2 Pres Cal (P1)	X.XXX	Vdc	
Balance Pressure (P2)	XX.XX	psi	XXX.XX
Balance Pres Cal (P2)	X.XXX	Vdc	
Mixer Output Pres (P3)	XX.XX	psi	XXX.XX
Mixer Output Pres Cal (P3)	X.XXX	Vdc	
ADC Ref Voltage	X.XXX	Vdc	

8a.2.4 Mixer Temperature

Selecting ***Mixer Temperatures*** brings up the Mixer Temperatures Gas Diagnostics page.

Gas Diagnostics
Gas Supplies
Mixer Output
Mixer Tests and Pres
Mixer Temperatures
O2 Flow: 0.5
N2O Flow: OFF
Air Flow: OFF
Breathing Sys Leak
-> Main Menu

Mixer Temperatures Gas Diagnostics

Sensor Data	Value	Units
O2 Temp (T1)	XX.X	Deg C
O2 Temp Volts (T1)	X.XXX	Vdc
Balance Temp (T2)	XX.X	Deg C
Balance Temp Volts (T2)	X.XXX	Vdc
ADC Ref Voltage	X.XXX	Vdc

8a.2.5 Setting Gas Flow

Selecting ***O2 Flow: OFF*** brings up the O2 Flow Setting page on which you can select one of four flows (or OFF if flow previously set):

- 0.2 l/min
- 0.5 l/min
- 5.0 l/min
- 10.0 l/min

Selecting “N2O Flow: OFF” or “Air Flow: OFF” brings up a comparable page for setting the above flows for the selected gas. Selecting a flow for a new gas turns the previous gas flow to OFF.

Gas Diagnostics
Gas Supplies
Mixer Output
Mixer Tests and Pres
Mixer Temperatures
O2 Flow: OFF
N2O Flow: OFF
Air Flow: OFF
Breathing Sys Leak
-> Main Menu

O2 Flow Setting

	Value	**Units**
O2 Flow	X.X	l/min

To choose a gas flow, turn ComWheel.

Gas flows do not change until you push ComWheel.

Airway pressure:	XXX	cmH2O

Push ComWheel to Exit and start O2 flow ->

After setting a gas flow, push the ComWheel again to return to the Flow Setting page to observe the Airway Pressure reading, or select one of the four diagnostics pages to view the displayed conditions.

All gas flow stops when you exit Gas Diagnostics to the Main Menu.

8a.2.6 Breathing System Leak Test

Selecting ***Breathing Sys Leak*** brings up the Breathing Sys Leak page.

Entering the Breathing Sys Leak page, opens the Gas Inlet Valve and sets up a constant flow through the Inspiratory Flow Valve.

On the Breathing Sys Leak page you can set an O2 flow through the Gas Mixer and view the Airway Pressure.

Gas Diagnostics
Gas Supplies
Mixer Output
Mixer Tests and Pres
Mixer Temperatures
O2 Flow: OFF
N2O Flow: OFF
Air Flow: OFF
Breathing Sys Leak
-> Main Menu

Breathing Sys Leak

Breathing Sys Leak Test: Flow valve and GIV valve are open.

	Value	**Units**
O2 Flow	X.X	l/min

To choose a gas flow, turn ComWheel.

Gas flows do not change until you push ComWheel.

Refer to Technical Reference Manual for this procedure.

Airway pressure:	XXX	cmH2O

Second ComWheel Push Ends Test ->

All gas flow stops when you exit Gas Diagnostics to the Main Menu.

Note This procedure is detailed in Test 6, "*Testing the bellows module and the Bag/Vent switch*" on page 7-21.

8a.3 Ventilation Diagnostics

The service application provides several pages for ventilation diagnostics.

Selecting ***Vent Diagnostics*** on the Main Menu brings up the following menu selections in the left-hand frame and the instructions in the right-hand frame:

Main Menu
Power Diagnostics
Gas Diagnostics
Vent Diagnostics
Display Diagnostics
Special Functions

Software Download

Vent Diagnostics	**Vent Diagnostics**
Status Vent Flow and Pres Gas Inlet Vlv ON/OFF Flow Valve Control Toggle Circuit -> Main Menu	Status data shows the position of breathing circuit switches. Vent Flow and Pres shows vent sensor readings. Other commands in the menu column let you control ventilator valves and send gas to either the circle or the non-circle circuit.

Vent Diagnostics	**Action when selected**
Status	Selecting ***Status*** displays the Ventilation Status page.
Vent Flow and Pres	Selecting ***Vent Flow and Pres*** displays the Ventilation Flow and Pressure page.
Gas Inlet Vlv ON/OFF	Selecting ***Gas Inlet Vlv ON/OFF*** toggles the Gas Inlet Valve to the Open or Closed position and sets the right-hand screen to the Vent Flow and Pressure Diagnostics page.
Flow Valve Control	Selecting ***Flow Valve Control*** sets the right-hand screen to the Vent Flow and Pressure Diagnostics page and allows the user to increase or decrease the DAC count to the flow valve using the ComWheel.
Toggle Circuit	Selecting ***Toggle Circuit*** toggles between commanding Circle or Non-Circle for the SCGO valve and sets the right-hand screen to the Vent Status page (does not apply to machines with ACGO).
->Main Menu	Selecting ***Main Menu*** closes the Gas Inlet Valve and the Flow Valve and return to the Main Menu.

The actions of the Gas Inlet, the Flow Valve Control, and the Circuit selection are reflected on both the Ventilation Status page and the Ventilation Flow and Pressure page.

The Gas Inlet Valve must be in the ON position in order for gas to flow.

8a.3.1 Status

Selecting ***Status*** brings up the Ventilation Status page.

Vent Diagnostics
Status
Vent Flow and Pres
Gas Inlet Vlv ON/OFF
Flow Valve Control
Toggle Circuit
-> Main Menu

Vent Status

Menu Item	Value	Units
Gas Inlet Valve	Open or Closed	
Flow Valve	XXXXX	Counts
Circuit Command	Circle or Non-Circle	
Vent Drive Gas	Air or O2	
ABS Installed	Yes or No	
Flush Valve	Not Pressed or Pressed	
O2 Cell Status	Connected or None	
Bag/Vent Switch	Bag or Vent	
Circuit Feedback	Circle, Non-Circle, or Fault	
ACGO/SCGO Configuration	ACGO or SCGO	
Over Pressure Circuit	OK or High Pressure	
Gas Inlet Valve Feedback	Open or Closed	

8a.3.2 Vent Flow and Pressure

Selecting ***Vent Flow and Pres*** brings up the Ventilation Flow and Pressure page.

Vent Diagnostics
Status
Vent Flow and Pres
Gas Inlet Vlv ON/OFF
Flow Valve Control
Toggle Circuit
-> Main Menu

Vent Flow and Pressure Diagnostics

Menu Item	**Value**	**Units**	**Value**	**Units**
Gas Inlet Valve	Open or Closed			
Flow Valve	XXXXX	Counts		
Turn ComWheel to adjust flow valve		(appears when Flow Valve Control set ON)		
Circuit Command	Circle or Non-Circle			
Inspiratory Flow	XXX.X	l/min	XXXX	Counts
Expiratory Flow	XXX.X	l/min	XXXX	Counts
Airway Pressure	XX X	cmH2O	XXXX	Counts
Manifold Pressure	XXX	cmH2O	XXXX	Counts
O2 Cell	XXX	%	XXXX	Counts
ADC Ref Voltage	X.XXX	Vdc		
Flow Valve Setting	XXX.X	l/min	XXXX	Counts
Flow Valve Feedback	xxxx	mV	XXXX	Counts
Flow Valve Current	xxxx	mA	XXXX	Counts

8a.4 Display Diagnostics

The service application provides several pages for display diagnostics.

Selecting ***Display Diagnostics*** on the Main Menu brings up the following menu selections in the left-hand frame:

Main Menu
Power Diagnostics
Gas Diagnostics
Vent Diagnostics
Display Diagnostics
Special Functions

Software Download

Display Diagnostics	**Display Diagnostics Instructions**
Test LEDs	Select a menu item
Test Speaker	To troubleshoot a display problem, start with Test LEDs and work forward
Test Backlight 1	
Test Backlight 2	
Test Keys	
-> Main Menu	

Display Diagnostics	**Action when selected**
Test LEDs	Selecting ***Test LEDs*** causes the red and yellow LEDS next to the **Silence Alarms** key to flash for 10 seconds.
Test Speaker	Selecting ***Test Speaker*** causes the speaker to sound for 5 seconds.
Test Backlight 1	Selecting ***Test Backlight 1*** turns backlight 2 off for 10 seconds. "If screen goes black during test, a backlight is out."
Test Backlight 2	Selecting ***Test Backlight 2*** turns backlight 1 off for 10 seconds. "If screen goes black during test, a backlight is out."
Test Keys	Selecting ***Test Keys*** brings up a representative display of the front panel controls. Pressing a softkey will cause the corresponding key text to be highlighted.
Main Menu	Selecting ***Main Menu*** returns to the Main Menu.

8a.5 Special Functions

Selecting ***Special Functions*** on the Main Menu brings up the following menu selections in the left-hand frame:

Note The *View Error Log*, *View Alarm Log*, and *View Event Log* may not be present on all versions of the Software Downloader Card.

Main Menu
Power Diagnostics
Gas Diagnostics
Vent Diagnostics
Display Diagnostics
Special Functions

Software Download

Special Functions	**Special Functions**
Mixer Service Menu View Error Log View Alarm Log View Event Log View Revision Log Compatibility Table PC Card Install Log View Install Errors -> Main Menu	

Mixer Service Menu Refer to section 8a.5.1.

Error, Alarm, Event Logs In a functioning system, the Error, Alarm, and Event Logs are accessible on the system's Service Log menu (refer to *Section 4a.4.2*). If a system comes up in a "Failed State", you can download the logs to the Service Application PC Card and view them on the Special Functions screen.

1. With the system still in the "Failed State", insert the Service Application PC Card into the Display Unit and press the "Help" softkey.
2. Wait approximately 60 seconds while the logs are downloaded to the card (no apparent activity).
3. Restart the system with the Service Application to view the logs.

Revision and PC Card Install Logs Whenever a Software Download is completed, the specific software download is recorded in the Revision Log that resides on the system (Display Unit) and in the PC Card Install Log that resides on the PC Card.

Compatibility Table The Compatibility Table lists the current software components that last downloaded on to the system. In essence, it is the latest listing that appears in the Revision Log, which allows you to view the current log directly without having to scroll to it.

8a.5.1 Mixer Service Menu

Selecting ***Mixer Service Menu*** brings up the Mixer Service Instructions.

Note: This function is not valid on the PCMCIA card and has been moved to the main System Software (*Section 4a.5.9*) for Software versions 3.X and greater.

Mixer Service Menu	Mixer Service Instructions
Zero Pres Sensors Reset Defaults -> Special Functions	Select Zero Pres Sensors to recalibrate the pressure sensor zero-offsets. Select Reset Defaults to restore factory default offsets. If you want to select Zero Pres Sensors . . . 1) Disconnect gas supplies from system. 2) Close cylinders. 3) Confirm that all vaporizers are turned "OFF". 4) Remove the flow sensor cover. 5) Move the Bag-to-Vent switch to the Bag position. 6) Press the O2 Flush button for 3 seconds. 7) WAIT AT LEAST 5 MINUTES WITH NO GAS FLOWING. 8) Select Zero Pres Sensors on the menu. If you want to select Zero Pres Sensors . . . DO NOT DISTURB THE SYSTEM WHILE WAITING FOR RESULTS.

Zero mixer pressure sensors

Mixer Service Menu	Zero Pres Sensors
Zero Pres Sensors Reset Defaults -> Special Functions	Pressure sensor zero-offset adjust requested. Note: this procedure will require at least 2 minutes.

Reset factory default zero offsets

Mixer Service Menu	Zero Pres Sensors
Zero Pres Sensors Reset Defaults -> Special Functions	Reset to Factory Defaults requested.

8a.5.2 View Revision Log

Selecting ***View Revisions Log*** brings up the Revision Log for the system. The log includes chronological entries for every Software Download that was completed to the system. Each entry includes two header lines and eight data lines in the following format:

View Revision Log

```
# Software configuration after download on (day) (date) (time)
# SvcApp Version (XX.XX), Machine Serial Number (ABCDXXXXX)
Avance ACB, (Stock Number) (RevX),   (Software Level),  (File Name)  (Serial #)  AnesControl B
Avance MXR, (Stock Number) (RevX),   (Software Level),  (File Name)  (Serial #)  Electronic Mix
Avance VNT, (Stock Number) (RevX),   (Software Level),  (File Name)  (Serial #)  Vent Intface B
Avance FPC,                      *,  (Software Level),  (File Name)  (#---------)  Front Panel CN
Avance PSC, (Stock Number) (RevX),   (Software Level),  (File Name)  (Serial #)  Power Controll
Avance DUA,                      *,  (Software Level),  (File Name)  (#--------)  Dsply Unit App
Avance DUB, (Stock Number) (RevX),   (Software Level),  (File Name)  (Serial #)  Dsply Unit BIO
Avance DUF,                      *,  (Software Level),  (File Name)  (#---------)  Dsply Unit Fla
```

Note The Stock Number listed is for the board assembly and may not represent an orderable service item. Refer to the parts lists in Section 10 for service level stock numbers.

The Front Panel Control (FPC), Display Unit Application (DUA), and the Display Unit Flash (DUF) reside, along with the Display Unit BIOS (DUB), on the Display Unit CPU board.

8a.5.3 View PC Card Install Log

Selecting ***View PC Card Install Log*** brings up the PC Card Install Log for the software download card. The log includes chronological entries for every Software Download that was completed with the card. Each entry includes two header lines and eight data lines in the following format:

PC Card Install Log

```
INSTALLATION LOG for PC Card # XXXXXXX

# Software configuration after download on (day) (date) (time)
# SvcApp Version (XX.XX), Machine Serial Number (ABCDXXXXX), Card # XXXXXXX/
Avance ACB, (Stock Number) (RevX),   (Software Level),  (File Name)  (Serial #)  AnesControl B
Avance MXR, (Stock Number) (RevX),   (Software Level),  (File Name)  (Serial #)  Electronic Mix
Avance VNT, (Stock Number) (RevX),   (Software Level),  (File Name)  (Serial #)  Vent Intface B
Avance FPC,                      *,  (Software Level),  (File Name)  (#---------)  Front Panel CN
Avance PSC, (Stock Number) (RevX),   (Software Level),  (File Name)  (Serial #)  Power Controll
Avance DUA,                      *,  (Software Level),  (File Name)  (#--------)  Dsply Unit App
Avance DUB, (Stock Number) (RevX),   (Software Level),  (File Name)  (Serial #)  Dsply Unit BIO
Avance DUF,                      *,  (Software Level),  (File Name)  (#---------)  Dsply Unit Fla
```

8a.6 Software Download

Main Menu
Power Diagnostics
Gas Diagnostics
Vent Diagnostics
Display Diagnostics
Special Functions

Software Download

Selecting ***Software Download*** bring up the following information page:

ENTERING SOFTWARE DOWNLOAD MODE!

To return to Diagnostics: turn On/Standby switch to Standby, and turn off AC mains switch in rear. Wait 20 seconds, then turn on power with the AC mains switch and the On/Standby switch.

(Press ComWheel to continue with Download.)

Note You can not return to the Diagnostic section of the service application after entering the software download section. You must reboot the system to exit Software Download.

Entering software download brings up the Software Download menu.

Software Download	Remarks
Download All	Downloads all software subsystems.
Download New	Downloads only new software versions not found on the system and compatible with installed subsystem hardware.

Since downloading all the subsystem software can take an hour or more, you should normally choose “Download New” to install only the updated subsystem software or software required for newly installed subsystems.

Software Download
Download All
Download New

Software Download Status

Subsystem	HW Rev	Current SW Ver #	New SW Ver #	Status
Front Panel Cntl	XXX/A/XX	XX.XX	XX.XX	Xxxxxxx
Power Controller	XXX/A/XX	XX.XX	XX.XX	Xxxxxxx
Electronic Mixer	XXX/A/XX	XX.XX	XX.XX	Xxxxxxx
Vent Intface Bd	XXX/A/XX	XX.XX	XX.XX	Xxxxxxx
Anes Control Brd	XXX/A/XX	XX.XX	XX.XX	Xxxxxxx
Dsply Unit BIOS	XXX/A/XX	XX.XX	XX.XX	Xxxxxxx
Dsply Unit Flash		- - -		Xxxxxxx
Dsply Unit App	XXX/A/XX	XX.XX	XX.XX	Xxxxxxx

Loading Xxxx Xxxxxxxxx Xxxxx:
****

Notes about downloading software

If there is no Front Panel Control software installed in the system (as would be the case when the display units control board is replaced), the Service Application automatically downloads the Front Panel Controls software at startup. During the download the two display unit LEDs will flash and the display speaker will sound an alarm tone to indicate that Software Download is proceeding. The display will be black until the automatic download is complete.
To ensure that all software versions on the system are compatible, the end result of "Download All" or "Download New" will be the same. The software loaded on the machine will exactly match what is on the card. Be sure to have the latest/correct version of software before attempting a download to avoid inadvertent overwrites of newer software with an older version.
If, during the "Download New" process, the compatibility checker detects a newer version of software component on the system, a "Notice" appears on the screen that asks you to confirm the downgrade.
"Download All" will download all compatible software from the card to the system without issuing a notice that newer version of software component may be on the system.

Download process

The PCMCIA card includes only the latest software for each subsystem along with the diagnostic application.

As each subsystem software segment is being downloaded, the following status messages note the state of each subsystem and the result of the download:

- ***Busy*** - System is running its application code; not ready for download.
- ***Ready*** - System is in its boot code; ready for download.
- ***CRCtest*** - System is analyzing the download CRC.
- ***Loading*** - System is accepting download data.
- ***Done*** - Software download has completed successfully.
- ***Fail*** - Software download did not complete successfully. A "Fail" message will require reloading of the software; or repair of the system may be necessary.
- ***Skipped*** - Software download was bypassed.
- ***Linked*** - System is communicating, but status is not yet known.
- ***Not Compatible*** - The software version on the PCMCIA card is not compatible with the subsystem.

If the subsystem is communicating but the HW Rev or current SW Rev are not known, the message ***Unknown*** will appear under the columns for those values. If the HW Rev or current SW Rev are not known, the download function will still be available.

As the software loads, an activity bar at the bottom of the screen shows the download progress for each subsystem.

Download complete

When all the required subsystem software is download, the following message appears on the screen. You must shut down the system to exit the download function.

DOWNLOAD IS COMPLETE.
Remove PCMCIA card. Turn ON/STANBY switch to STANDBY. Turn OFF AC mains switch in rear.

Note

After powering down the system, be sure to wait at least 20 seconds before restarting the system.

8b Software Download and Special Functions (HPDU)

In this section

8b.1 Overview

This section covers the functions of the Compact Flash card used to download system software or to access Special Functions (diagnostics and logs) from the High Performance Display Unit.

To run the application, first set the system switch to Standby and set the AC Inlet power switch to Off. Insert the Compact Flash card into the interface slot of the display unit, then set the AC Inlet power switch and the system switch to On. The application will load and display the Main Menu along with the System Information page.

8b.1.1 Main Menu and System Information

The Main Menu appears on the left-hand side of the screen and includes the following selections as shown in the table below:

Main Menu	Remarks
Software Download	Access to the Software Download function.
Special Functions	Access to diagnostics and logs from the Display Unit.

Note You cannot return to the Special Functions section after entering the Software Download section. You must reboot the system to exit Software Download.

The System Information page appears on the right-hand side of the screen and displays the following system information as shown in the table below:

System Serial Number
ABCDXXXXXXXXX

Main Menu
Software Download
Special Functions

Avance System Information

Subsystem	HW Rev	Serial #	SW Ver	BootVer
	Currently Installed			
Front Panel Cntl	n/a	n/a	XX.XX	XXbXX
Power Controller	XXXX/A /XX	ABCXXXXX	XX.XX	XXbXX
Electronic Mixer	XXXX/A /XX	ABCXXXXX	XX.XX	XXbXX
Vent Intface Bd	XXXX/A /XX	ABCXXXXX	XX.XX	XXbXX
Anes Control Bd	XXXX/A /XX	ABCXXXXX	XX.XX	XX.XX
Dsply Unit BIOS	XXXX/XX/XX	ABCXXXXX	XX.XX	n/a
Dsply Unit App	XXX/XX/XX	ABCXXXXX	XX.XX	n/a

8b.2 Software Download

Selecting ***Software Download*** bring up the Software Download menu.

Software Download	Remarks
Download New	Downloads only new software versions not found on the system and compatible with installed subsystem hardware.
Download All	Downloads all software subsystems.

Note You cannot return to the Special Functions section after entering the Software Download section. You must reboot the system to exit Software Download.

Since downloading all the subsystem software can take up to 30 minutes, you should normally choose "Download New" to install only the updated subsystem software or software required for newly installed subsystems.

System Serial Number
ABCDXXXXXXXXX

Software Download
Download New
Download All

Loading Avance Product Software Version XX.XX

	Currently Installed		New	
Subsystem	**HW Rev**	**SW Ver**	**SW Ver**	**Status**
Front Panel Cntl	n/a	XX.XX	XX.XX	Xxxxxxx
Power Controller	XXXX/A /XX	XX.XX	XX.XX	Xxxxxxx
Electronic Mixer	XXXX/A /XX	XX.XX	XX.XX	Xxxxxxx
Vent Intface Bd	XXXX/A /XX	XX.XX	XX.XX	Xxxxxxx
Anes Control Bd	XXXX/A /XX	XX.XX	XX.XX	Xxxxxxx
Dsply Unit BIOS	XXXX/XX/XX	XX.XX	XX.XX	Xxxxxxx
Dsply Unit App	XXX/XX/XX	XX.XX	XX.XX	Xxxxxxx
ModBus Controllr	n/a	XX.XX	XX.XX	Xxxxxxx
Dsply Unit FontC	n/a	XX.XX	XX.XX	Xxxxxxx
Dsply Unit FontJ	n/a	XX.XX	XX.XX	Xxxxxxx

Note Whenever a Software Download is completed, the specific software download is recorded in the following logs:

- in the System Download Log (*Section 8b.8.1*) that resides on the system (Display Unit)
- and in the CF Card Install Log (*Section 8b.8.2*) that resides on the Compact Flash card.

Notes about downloading software

If there is no Front Panel Control software installed in the system (as would be the case when the display units control board is replaced), the Service Application automatically downloads the Front Panel Controls software at startup. During the download the two display unit LEDs will flash and the display speaker will sound an alarm tone to indicate that Software Download is proceeding.
To ensure that all software versions on the system are compatible, the end result of “Download All” or “Download New” will be the same. The software loaded on the machine will exactly match what is on the card. Be sure to have the latest/correct version of software before attempting a download to avoid inadvertent overwrites of newer software with an older version.
If, during the “Download New” process, the compatibility checker detects a newer version of software component on the system, a “Notice” appears on the screen that asks you to confirm the downgrade.
“Download All” will download all compatible software from the card to the system without issuing a notice that newer version of software component may be on the system.

Download process

The PCMCIA card includes only the latest software for each subsystem along with the diagnostic application.

As each subsystem software segment is being downloaded, the following status messages note the state of each subsystem and the result of the download:

- ***In App*** - System is running its application code; not ready for download.
- ***Ready*** - System is in its boot code; ready for download.
- ***Loading*** - System is accepting download data.
- ***Done*** - Software download has completed successfully.
- ***Fail*** - Software download did not complete successfully. A “Fail” message will require reloading of the software; or repair of the system may be necessary.
- ***Skipped*** - Software download was bypassed.
- ***No Comm*** - The subsystem is not communicating with the HPDU.

If the subsystem is communicating but the HW Rev or current SW Rev are not known, dashes will appear for those values.

As the software loads, an activity bar at the bottom of the screen shows the download progress for each subsystem.

Download complete

When all the required subsystem software is download, the following message appears on the screen. You must shut down the system to exit the download function.

DOWNLOAD IS COMPLETE. Remove AC mains power. Turn on/standby switch to Standby. Then remove external CF card. Wait 20 seconds before restoring power to the system.

Note

After powering down the system, be sure to wait at least 20 seconds before restarting the system.

8b.3 Special Functions

Selecting ***Special Functions*** on the Main Menu brings up the following menu selections in the left-hand frame:

Note Some functions may not be present on all versions of the Software Downloader Card.

Special Functions
Power Diagnostics
Vent Diagnostics
Gas Diagnostics
Mixer Service
Display Diagnostics
Compatibility Table
System Download Log
CF Card Install Log
View Install Errors
-> Main Menu

8b.3.1 Power Diagnostics

The service application provides power supply diagnostics for various circuit boards in the Avance anesthesia machine.

Selecting ***Power Diagnostics*** on the Special Functions menu brings up the following menu selections.

Power Diagnostics
Power Controller
Display Unit Power
Anes Control Board
Mixer
Vent Interface Bd
-> Previous Menu

8b.3.2 Power Controller Power Diagnostics

There are two pages of diagnostics for the Power Controller.

Selecting ***Power Controller*** brings up the first page of the Power Controller Readings.

Power Diagnostics
Power Controller
Display Unit Power
Anes Control Board
Mixer
Vent Interface Bd
-> Previous Menu

Power Controller Readings, page 1

Label	Value Format	Units	Normal range
AC Status	OK, Fail		
12Vdc Supply	XX.XX	Vdc	11.70 to 12.30
3.3Vdc Supply	X.XXX	Vdc	3.201 to 3.399
1.5 Vdc Supply	X.XXX	Vdc	1.450 to 1.550
Battery Connected	Yes, No		
Battery Status	Fail Bulk Chg Over Chg Float Chg Trickle Chg Discharge		
Battery Current	X.XX	A	
Battery 1 Volts	XX.XX < 6.0 FAIL (red) <10 T Chg (yellow) 10-16.5 (Green)	Vdc	10.0 to 16.50
Battery 2 Volts	XX.XX < 6.0 FAIL (red) <10 T Chg (yellow) 10-16.5 (Green)	Vdc	10.0 to 16.50
Calc Battery Time	XX	Min	
Date battery Tested (*)	XX-ABC-XXXX		
Last Full Discharge Time (*)	XX	Min	

Turn the ComWheel to select the second page.

Push the ComWheel to return focus to the Power Diagnostics selection menu.

(*) These entries are only listed after a full discharge test of the batteries is first performed (Section 6.10, "*Battery capacity test*"). These entries are not affected by the battery test in the display diagnostics section (Section 8b.7.1, "*Test Keys and Battery*").

Power Diagnostics
Power Controller
Display Unit Power
Anes Control Board
Mixer
Vent Interface Bd
-> Previous Menu

Power Controller Readings, page 2

Label	Value Format	Units	Normal range
Board Temperature	<65C OK (green) >65C <75C Warn (Yellow) >75C Fail (red)	Deg C	Upper 65
Fan Speed	Slow, Fast		
Fan 1 Voltage	XX.XX	Vdc	10.08 to 10.92
Fan 1 Status	Low, High, Fail, OK		

Turn the ComWheel to return to the first page.

Push the ComWheel to return focus to the Power Diagnostics selection menu.

8b.3.3 Display Unit Power Diagnostics

Selecting ***Display Unit Power*** brings up the Display Unit Power Diagnostics page.

Power Diagnostics
Power Controller
Display Unit Power
Anes Control Board
Mixer
Vent Interface Bd
-> Previous Menu

Display Unit Power Readings

Label	Value Format	Units	Normal range
12.5V Backlight	XX.XX	Vdc	10.54 to 14.87
5V Audio Power	X.XX	Vdc	4.39 to 5.72
3.3V Digital	X.XX	Vdc	2.86 to 3.81
3.3V LCD	X.XX	Vdc	2.86 to 3.81
Inverter A	X.XX	Vdc	0.00 to 1.09
Inverter B	X.XX	Vdc	0.00 to 1.09
Ground 1	X.XX	Vdc	0.00 to 0.11
Ground 2	X.XX	Vdc	0.00 to 0.11

8b.3.4 Anesthesia Control Board Power Diagnostics

There are two pages of diagnostics for the Anesthesia Control board.

Selecting ***Anes Control Board*** brings up the first page of the Anesthesia Control Board Power Readings.

Power Diagnostics
Power Controller
Display Unit Power
Anes Control Board
Mixer
Vent Interface Bd
-> Previous Menu

Anesthesia Control Board Power Readings, page 1

Label	Value Format	Units	Normal range
12.5Vdc from Pwr Cntrl	XX.XX	Vdc	11.90 to 12.90
ADC Reference	X.XXX	Vdc	4.018 to 4.176
Gas Select 10VA Volts	OK, Fail		
Gas Select 10VA Amps	OK, Fail		
P Xducer 10VA Amps	OK, Fail		
Vent Int Bd 10VA Volts	OK, Fail		
Vent Int Bd 10VA Amps	OK, Fail		
Vent Valves 10VA Volts	OK, Fail		
Vent Valves 10VA Amps	OK, Fail		
Acces 1 10VA Volts	OK, Fail		
Acces 1 10VA Amps	OK, Fail		

Turn the ComWheel to select the second page.

Push the ComWheel to return focus to the Power Diagnostics selection menu.

Power Diagnostics
Power Controller
Display Unit Power
Anes Control Board
Mixer
Vent Interface Bd
-> Previous Menu

Anesthesia Control Board Power Readings, page 2

Label	Value Format
Gas Unit 10VA Volts	OK, Fail
Gas Unit 10VA Amps	OK, Fail
Mixer 10VA Volts	OK, Fail
Mixer 10VA Amps	OK, Fail
Alt O2 10VA Volts	OK, Fail
Alt O2 10VA Amps	OK, Fail
Periph 1 10VA Volts	OK, Fail
Periph 1 10VA Amps	OK, Fail
Periph 2 10VA Volts	OK, Fail
Periph 2 10VA Amps	OK, Fail

Turn the ComWheel to return to the first page.

Push the ComWheel to return focus to the Power Diagnostics selection menu.

8b.3.5 Electronic Mixer Power Diagnostics

Selecting ***Mixer*** brings up the Electronic Mixer Power Diagnostics page.

Power Diagnostics
Power Controller
Display Unit Power
Anes Control Board
Mixer
Vent Interface Bd
-> Previous Menu

Mixer Power Readings

Label	**Value Format**	**Units**	**Normal range**
From Anes Cntrl Bd			
Mixer 10VA Volts	OK, Fail		
Board Supplies			
12.5 V	XX.XX	Vdc	11.80 to 13.00
5.5V	X.XXX	Vdc	5.390 to 5.610
3.3V CPU	X.XXX	Vdc	3.220 to 3.380
2.5V ADC Ref	X.XXX	Vdc	2.470 to 2.530

8b.3.6 Ventilator Interface Board Power Diagnostics

Selecting ***Vent Interface Board*** brings up the Ventilator Interface Board Power Diagnostics page.

Power Diagnostics
Power Controller
Display Unit Power
Anes Control Board
Mixer
Vent Interface Bd
-> Previous Menu

Vent Interface Bd Power Readings

Label	**Value Format**	**Units**	**Normal range**
From Anes Cntrl Bd			
Vent Int Bd 10VA Volts	OK, Fail		
Vent Valves 10VA Volts	OK, Fail		
Board Supplies			
Vent Int Bd 10VA Volts	XX.XX	Vdc	11.30 to13.13
Vent Valves 10VA Volts	XX.XX	Vdc	11.30 to13.13
3.2Vdc (12bit Vref)	X.XXX XXXX	Vdc Counts	3.179 to 3.221
1.22Vdc (10bit Vref)	X.XXX XXXX	Vdc Counts	1.074 to 1.367
+6.0Vdc	X.XXX	Vdc	5.510 to 6.500
-6.0Vdc	-X.XXX	Vdc	-6.720 to -5.280

8b.4 Ventilation Diagnostics

The service application provides several pages for ventilator diagnostics.

Selecting ***Vent Diagnostics*** on the Special Functions menu brings up the following menu selections in the left-hand frame and the instructions in the right-hand frame:

Special Functions
Power Diagnostics
Vent Diagnostics
Gas Diagnostics
Mixer Service
Display Diagnostics
Compatibility Table
System Download Log
CF Card Install Log
View Install Errors
-> Main Menu

Vent Diagnostics	Ventilator Diagnostics
Vent Status Vent Flow and Pressure Toggle Gas Inlet Vlv Toggle Circuit Set Flow Valve -> Previous Menu	Vent Status shows the settings of breathing circuit switches. Vent Flow and Pressure shows vent sensor readings. Other menu commands let you control ventilator valves, and send gas to either the circle or the non-circle circuit.

Vent Diagnostics	Action when selected
Vent Status	Selecting ***Vent Status*** displays the Ventilation Status page.
Vent Flow and Pressure	Selecting ***Vent Flow and Pressure*** displays the Ventilation Flow and Pressure page.
Toggle Gas Inlet Vlv	Selecting ***Toggle Gas Inlet Vlv*** alternately sets the Gas Inlet Valve to the Open or Closed position and sets the right-hand screen to the Ventilator Flow and Pressure page.
Toggle Circuit	Selecting ***Toggle Circuit*** toggles between commanding Circle or Non-Circle for the SCGO valve and sets the right-hand screen to the Ventilator Flow and Pressure page (does not apply to machines with ACGO).
Set Flow Valve	Selecting ***Set Flow Valve*** sets the right-hand screen to the Ventilator Flow and Pressure page and allows the user to increase or decrease the DAC count to the flow valve using the ComWheel.
->Previous Menu	Selecting ***Previous Menu*** closes the Gas Inlet Valve and the Flow Valve and returns to the Special Functions menu.

The actions of the Gas Inlet, the Flow Valve Control, and the Circuit selection are reflected on both the Ventilation Status page and the Ventilation Flow and Pressure page.

The Gas Inlet Valve must be in the Open position in order for gas to flow.

8b.4.1 Vent Status

Selecting ***Vent Status*** brings up the Ventilation Status page.

Vent Diagnostics
Vent Status
Vent Flow and Pressure
Toggle Gas Inlet Vlv
Toggle Circuit
Set Flow Valve
-> Previous Menu

Ventilator Status

Menu Item	**Value**
Gas Inlet Valve Setting	Open or Closed
Gas Inlet Valve Feedback	Open or Closed, or Fault
Circuit Setting	Circle or Non-Circle
Circuit Feedback	Circle, Non-Circle, or Fault
Vent Drive Gas	Air or O2
ABS Installed	Yes or No
Flush Valve	Not Pressed or Pressed
O2 Cell Status	Connected or None
Bag/Vent Switch	Bag or Vent
ACGO/SCGO Configuration	ACGO or SCGO
Over Pressure Circuit	OK or High Pressure

8b.4.2 Vent Flow and Pressure

Selecting ***Vent Flow and Pressure*** brings up the Ventilation Flow and Pressure page.

Vent Diagnostics
Vent Status
Vent Flow and Pressure
Toggle Gas Inlet Vlv
Toggle Circuit
Set Flow Valve
-> Previous Menu

Ventilator Flow and Pressure

Menu Item	Value	Units	Value	Units
Gas Inlet Valve Setting	Open or Closed			
Gas Inlet Valve Feedback	Open or Closed, or Fault			
Circuit Setting	Circle or Non-Circle			
Circuit Feedback	Circle, Non-Circle, or Fault			
Inspiratory Flow	XXX.X	l/min	XXXX	Counts
Expiratory Flow	XXX.X	l/min	XXXX	Counts
Airway Pressure	XXX	cmH2O	XXXX	Counts
Manifold Pressure	XXX	cmH2O	XXXX	Counts
O2 Cell	XXX	%	XXXX	Counts
ADC Ref Voltage	X.XXX	Vdc		
Flow Valve Setting	XXX.X	l/min	XXXX	Counts
Flow Valve Feedback	XXXX	mV	XXXX	Counts
Flow Valve Current	XXXX	mA	XXXX	Counts
Flow Valve DAC Setting	XXXX	Counts		

↑↑↑

Turn ComWheel to adjust flow
Press the ComWheel to change flow setting

(appears when Set Flow Valve is selected on the Vent Diagnostics menu)

8b.5 Gas Diagnostics

Selecting ***Gas Diagnostics*** on the Special Functions menu brings up the following menu selections in the left-hand frame and the instructions in the right-hand frame.

Special Functions
Power Diagnostics
Vent Diagnostics
Gas Diagnostics
Mixer Service
Display Diagnostics
Compatibility Table
System Download Log
CF Card Install Log
View Install Errors
-> Main Menu

Gas Diagnostics	**Gas Diagnostics**
Gas Supplies Mixer Output Mixer Tests and Pres Mixer Temperatures Set 100% O2 Flow Set 100% N2O Flow Set Air Flow Breathing Sys Leak -> Previous Menu	To troubleshoot a problem with gas supplies or flows, select Gas Supplies. Then work down through other menu selections. To turn on gas flows, select Set O2, N2O, or Air Flow. Available flows are 0.2, 0.5, 5, and 10 l/min and OFF. Turning ON a different gas will turn OFF any other gas. All gas flows stop if you go back to the Previous Menu.
Settings O2 flow: XXX N2O flow: XXX Air flow: XXX	

Selecting any of the first four items in the left-hand frame, brings up the corresponding diagnostic page.

Press the ComWheel to return focus to the right-hand frame to make another selection.

Start gas flow

Selecting one of the three gas flows brings up a page on which you can set one of the following flow values for the selected gas:

- 0.2 l/min, 0.5 l/min, 5.0 l/min, 10.0 l/min, OFF.

Press the ComWheel to start the selected flow.

Press the ComWheel again to return to the flow page to observe the Airway Pressure reading. Or select one of the four diagnostics pages to view the displayed conditions.

Selecting Breathing Sys Leak, opens the GIV valve and sets a flow through the inspiratory flow valve. While on the Breathing Sys Leak page, you can set O2 flow to the breathing system and observe the Airway Pressure reading.

Stop gas flow

Gas will continue to flow at the set rate until you:

- set a different flow for the same gas,
- set a flow for a different gas (automatically turns the previous gas flow OFF),
- set the current gas flow to OFF (all flows OFF),
- exit Gas Diagnostics to the Special Functions menu.

8b.5.1 Setting Gas Flow

Gas Diagnostics
Gas Supplies
Mixer Output
Mixer Tests and Pres
Mixer Temperatures
Set 100% O2 Flow
Set 100% N2O Flow
Set Air Flow
Breathing Sys Leak
-> Previous Menu

Settings
O2 flow: XXX
N2O flow: XXX
Air flow: XXX

Selecting ***Set 100% O2 Flow*** brings up the Set Gas Flow page on which you can select one of the following flow values (or OFF if previously set to flow):

- 0.2 l/min
- 0.5 l/min
- 5.0 l/min
- 10.0 l/min
- OFF

Selecting ***Set 100% N2O Flow*** or ***Set Air Flow*** brings up a comparable page for setting the above flows for the selected gas. Selecting a flow for a new gas turns the previous gas flow to OFF.

Set Gas Flow

		Value	Units
Set O2 Flow		X.X	l/min
		↑↑↑	

Turn the ComWheel to select the gas flow.
Press the ComWheel to change flow setting.

Airway pressure:	XXX	cmH2O

After setting a gas flow, push the ComWheel again to return to the Flow Setting page to observe the Airway Pressure reading, or select one of the four diagnostics pages to view the displayed conditions.

All gas flow stops when you exit Gas Diagnostics to the Special Functions menu.

8b.5.2 Gas Supplies

Each gas supply shows the derived pressure in kPa and psi along with the raw voltage from the pressure transducer.

If a supply module for a gas is not installed, or if the transducer is disconnected, the supply shows dashed lines.

If a supply module is installed but no supply is connected, the supply shows approximately 0.500 Vdc.

The remaining items show the state of the Electronic Mixer selector valves.

Gas Diagnostics
Gas Supplies
Mixer Output
Mixer Tests and Pres
Mixer Temperatures
Set 100% O2 Flow
Set 100% N2O Flow
Set Air Flow
Breathing Sys Leak
-> Previous Menu

Settings
O2 flow: XXX
N2O flow: XXX
Air flow: XXX

Gas Supplies

Label	psi	kPa	Vdc
O2 Cylinder 1	XXXX	XXXXX	XX.XXX
O2 Cylinder 2	XXXX	XXXXX	XX.XXX
Air Cylinder	XXXX	XXXXX	XX.XXX
N2O Cylinder	XXXX	XXXXX	XX.XXX
O2 Pipeline	XXXX	XXXXX	XX.XXX
Air Pipeline	XXXX	XXXXX	XX.XXX
N2O Pipeline	XXXX	XXXXX	XX.XXX
O2 Select Valve	Open	Flow ON	
Air Select Valve	Closed	Flow OFF	
N2O Select Valve	Closed	Flow OFF	
Alt O2 Button	Not pressed		

Note: dashed pressure means supply is not installed or transducer is disconnected.

8b.5.3 Mixer Output

Selecting ***Mixer Output*** brings up the Mixer Output Gas Diagnostics page.

This data comes from the Anesthesia Control board. The Flow Verify signals are rough calculations of the mixer flow based on pressure drop and temperature. The ADC reference voltage is used to convert flow signals.

Gas Diagnostics
Gas Supplies
Mixer Output
Mixer Tests and Pres
Mixer Temperatures
Set 100% O2 Flow
Set 100% N2O Flow
Set Air Flow
Breathing Sys Leak
-> Previous Menu

Settings
O2 flow: XXX
N2O flow: XXX
Air flow: XXX

Mixer Output

Label	**Value**	**Units**
Measured O2 Flow	XX.XX	l/min
Meas. Balance Gas Flow	XX.XX	l/min
O2 Flow Verify	XX.XX	l/min
O2 Flow Signal	X.XXX	Vdc
O2 Prop Valve Drive	XXXX	mA
Balance Gas ID	None, Air, N2O	
Balance Flow Verify	XX.XX	l/min
Balance Flow Signal	X.XXX	Vdc
Balance Prop Valve Drive	XXXX	mA
O2 Select Valve	Open	
Air Select Valve	Closed	
N2O Select Valve	Closed	
ADC Ref Voltage	X.XXX	Vdc

8b.5.4 Mixer Tests and Pressure

Selecting ***Mixer Tests and Pres*** brings up the Mixer Tests and Pres Gas Delivery Diagnostics page.

Gas Diagnostics
Gas Supplies
Mixer Output
Mixer Tests and Pres
Mixer Temperatures
Set 100% O2 Flow
Set 100% N2O Flow
Set Air Flow
Breathing Sys Leak
-> Previous Menu

Settings
O2 flow: XXX
N2O flow: XXX
Air flow: XXX

Mixer Tests and Pressures

Last Power-Up Tests			
O2 Proportional Valve Leak	Not done. No supply pressure Not done. Selector valve incorrect state Pass Fail. Selector valve leaks Fail. Proportional valve leaks		
Alt O2 Valve Leak	Pass; Fail		
Balance Gas Prop Valve Leak	Not done. No supply pressure Not done. Selector valve incorrect state Pass Fail. Selector valve leaks Fail. Proportional valve leaks		
O2 Flow Test	Not done. No supply pressure; Not done. Selector valve incorrect state; Pass; Fail, 3 l/min test; Fail, 10 l/min test		
Balance Flow Test	Not done. No supply pressure; Not done. Selector valve incorrect state; Pass; Fail, 3 l/min test; Fail, 10 l/min test		
Balance Gas ID	None; Air; N2O		
Pressure Data	**Value**	**Units**	**kPa**
O2 Pressure (P1)	XX.XX	psi	XXX.XX
O2 Pres Cal (P1)	X.XXX	Vdc	
Balance Pressure (P2)	XX.XX	psi	XXX.XX
Balance Pres Cal (P2)	X.XXX	Vdc	
Mixer Output Pres (P3)	XX.XX	psi	XXX.XX
Mixer Output Pres Cal (P3)	X.XXX	Vdc	
ADC Ref Voltage	X.XXX	Vdc	

8b.5.5 Mixer Temperature

Selecting ***Mixer Temperatures*** brings up the Mixer Temperatures Gas Diagnostics page.

Gas Diagnostics
Gas Supplies
Mixer Output
Mixer Tests and Pres
Mixer Temperatures
Set 100% O2 Flow
Set 100% N2O Flow
Set Air Flow
Breathing Sys Leak
-> Previous Menu

Settings
O2 flow: XXX
N2O flow: XXX
Air flow: XXX

Mixer Temperatures

Sensor Data	Value	Units
O2 Temp (T1)	XX.X	Deg C
O2 Temp Volts (T1)	X.XXX	Vdc
Balance Temp (T2)	XX.X	Deg C
Balance Temp Volts (T2)	X.XXX	Vdc
ADC Ref Voltage	X.XXX	Vdc

8b.5.6 Breathing System Leak Test

Selecting ***Breathing Sys Leak*** brings up the System Leak Test page.

Entering the System Leak Test page, opens the Gas Inlet Valve and sets up a constant flow through the Inspiratory Flow Valve.

On the Breathing Sys Leak page you can set an O2 flow through the Gas Mixer and view the Airway Pressure.

Gas Diagnostics
Gas Supplies
Mixer Output
Mixer Tests and Pres
Mixer Temperatures
Set 100% O2 Flow
Set 100% N2O Flow
Set Air Flow
Breathing Sys Leak
-> Previous Menu

Settings
O2 flow: XXX
N2O flow: XXX
Air flow: XXX

System Leak Test

This is the Breathing System Leak Test. Refer to the Technical Reference Manual for this procedure.

	Value	**Units**
Set O2 Flow	X.X	l/min
	↑↑↑	

Turn the ComWheel to select the gas flow.
Press the ComWheel to change flow setting.

NOTE: Flow Valve and Gas Inlet Valve are OPEN.

Airway pressure:	XXX	cmH2O

All gas flow stops when you exit Gas Diagnostics to the Special Functions menu.

Note This procedure is detailed in Test 6, “*Testing the bellows module and the Bag/Vent switch*” on page 7-21.

8b.6 Mixer Service Menu

Selecting ***Mixer Service*** brings up the Mixer Service Functions screen. This screen includes and automatic and a manual leak test of the Mixer's balance gas inlet check valves.

Automatic

The ***BalGas Auto Leak*** test does not require disassembly of the system. It is a sensitive test that will Pass check valve that have leak rates within specifications; however, it may Fail some Mixers with marginal but acceptable leak rates.

- Mixers that Pass the auto leak test do not require further testing and can be left in service.
- Mixers that Fail the auto leak test should be further tested using the manual leak test.

Manual

The manual ***BalGas Leak Test*** requires disassembly of the system.

- Mixers that Pass the manual leak test have acceptable leak rates and can be left in service.
- Mixers that Fail the manual leak test should be replaced.

Special Functions
Power Diagnostics
Vent Diagnostics
Gas Diagnostics
Mixer Service
Display Diagnostics
Compatibility Table
System Download Log
CF Card Install Log
View Install Errors
-> Main Menu

Mixer Service	Mixer Service Functions
BalGas Auto Leak BalGas Leak Test -> Previous Menu	To troubleshoot mixer problems.

Automatic leak test

Selecting ***BalGas Auto Leak*** brings up the Service Instructions page for the automatic mixer leak test.

Service command	Service Instructions
Start Test -> Previous Menu	This will perform an Automatic Leak Test of the Balance Gas Check Valve...

1. Connect an O_2 supply.
2. Select ***Start Test*** to perform the automatic leak test.
   - If Pass, balance gas check valve leak rate is acceptable.
   - If Fail, verify leak rate using the following manual leak test.

Manual leak test

Selecting ***BalGas Leak Test*** brings up the Service Instructions page for the manual mixer leak test.

Service command	Service Instructions
Start Test -> Previous Menu	This will perform a Manual Leak Test of the Balance Gas Check Valve...

Select ***Start Test*** to perform the manual leak test as follows.

Selecting ***Start Test*** brings up the manual leak test setup instructions.

Service command
Start Test
-> Previous Menu

Service Instructions
This will perform a Manual Leak Test 1) Disconnect Oxygen and Bal Gas Supplies. 2) Remove rear cover (Avance) or dashboard (Aisys). 3) Disconnect mixer outlet tube (MIXER VAP IN) at the inlet to the vaporizer manifold (Avance), or Electronic Vaporizer (Aisys), and plug the Mixer outlet (1/4 Legris). 4) Disconnect the Mixer Alt O2 inlet tube at the On/Standby switch (SW4 - ALT O2 IN). 5) Connect a pressurization device with gauge to the Mixer Alt-O2 inlet tubing. Minimize the tubing length, as additional volumes will affect the leak rate. Push ComWheel to 'Start Test'.

Service Instructions
1) Slowly pressurize the Mixer to 400 mmHg (over a 5 second period), as read on the test device. 2) The Pressure shown on the test gauge should not decay to ambient (zero) in less than 10 seconds. 3) Select 'End Test' when done. Push ComWheel to 'End Test'.

Service Instructions
1) Remove all test fixtures. 2) Remove plugs and reconnect all tubing disconnected at the start of this test. 3) Re-attach Oxygen supply and activate 'Confirm'. Push ComWheel to 'Confirm'.

8b.7 Display Diagnostics

Selecting ***Display Diagnostics*** brings up the Display Diagnostics menu.

Special Functions
Power Diagnostics
Vent Diagnostics
Gas Diagnostics
Mixer Service
Display Diagnostics
Compatibility Table
System Download Log
CF Card Install Log
View Install Errors
-> Main Menu

Display Diagnostics	
Test LEDs	Board part #: XXX-XXX-XXX B XXX Serial #: ABCXXXXX
Test Speaker	
Test Backlight 1	BIOS Version: XX.XX FPC Version: XX.XX
Test Backlight 2	MBC Version X MAC Address: XX XX XX XX XX XX
Test Soft Keys	
Test Keys and Battery	Internal CF disk: --
Test LCD Pixels	Card geometry: --
	CPU Temperature = XX.X deg C
-> Previous Menu	CPU Fan Speed = XXXX RPM

Display Diagnostics	**Action when selected**
Test LEDs	Selecting ***Test LEDs*** causes the red and yellow LEDS next to the **Silence Alarms** key to flash 5 times.
Test Speaker	Selecting ***Test Speaker*** causes the speaker to sound for 2 seconds.
Test Backlight 1	Selecting ***Test Backlight 1*** turns backlight 2 off for 4 seconds. “If screen goes blank during test then a backlight is out.”
Test Backlight 2	Selecting ***Test Backlight 2*** turns backlight 1 off for 4 seconds. “If screen goes blank during test then a backlight is out.”
Test Soft Keys	On the ***Test Soft Keys*** screen, pressing a softkey will cause a highlighted square to appear next to the soft key. A second press of the softkey removes the square.
Test Keys and Battery	Refer to section 8b.7.1.
Test LCD Pixels	On the ***Test LCD Pixels*** screen, press the ComWheel to sequence through the color screens. The first press results in a “blank” screen.
-> Previous Menu	Selecting ***Previous Menu*** returns to the Special Functions screen.

8b.7.1 Test Keys and Battery

Note: System Software version 4.X only includes the ***Test Keys*** function. System Software version 5.X includes the combined ***Test Keys and Batery*** function.

Selecting ***Test Keys and Battery*** brings up an expanded test keys screen which includes the battery test.

Display Diagnostics
Test LEDs
Test Speaker
Test Backlight 1
Test Backlight 2
Test Soft Keys
Test Keys and Battery
Test LCD Pixels
-> Previous Menu

Test Soft Keys and Battery
Press each softkey to display a box. Press again to clear it. To start the battery test, shut off the AC mains. Then wait for the end of the 2-minute countdown. (You can test the keys while you wait.)

After turning off the AC main inlet switch, the test begins automatically in a few seconds.

Test Soft Keys and Battery
Press each softkey to display a box. Press again to clear it. Countdown = XXX sec Battery 1 (right) = XX.XX Vdc Battery 2 (left) = XX.XX Vdc Battery Current = -X.XX A -- Battery test PASSED/FAILED Restore AC mains power.

Note If the Avance system is operating under battery power, the test begins as soon as you make the ***Test Keys and Battery*** selection, bypassing the instructions.

8b.8 Compatibility Table

Selecting ***Compatibility Table*** brings up a list of the current software components that were last downloaded on to the system. In essence, it is the latest listing that appears in the Revision Log (*Refer to section 8b.8.1*). The Compatibility Table allows you to view the current log directly without having to scroll to it in the Revision Log.

Special Functions
Power Diagnostics
Vent Diagnostics
Gas Diagnostics
Mixer Service
Display Diagnostics
Compatibility Table
System Download Log
CF Card Install Log
View Install Errors
-> Main Menu

```
# System s/n ABCDXXXXXXXXX loaded by Download XXX on (day) (date) (time)
# using HPDU Softwr Loader & Svc Ver XX.XX from card [XXXX] to [XXXX}
System Version XX.XX
Avance FPC, *                          ,   (Software Level),   (File Name)   (#  n/a )  Front Panel CN
Avance PSC, (Stock Number) (RevX),     (Software Level),   (File Name)   (Serial #)  Power Controll
Avance ACB, (Stock Number) (RevX),     (Software Level),   (File Name)   (Serial #)  AnesControl B
Avance VNT, (Stock Number) (RevX),     (Software Level),   (File Name)   (Serial #)  Vent Intface B
Avance MXR, (Stock Number) (RevX),     (Software Level),   (File Name)   (Serial #)  Electronic Mix
Avance DUB, (Stock Number) (RevX),     (Software Level),   (File Name)   (Serial #)  Dsply Unit BIO
Avance DUA, (Stock Number) (RevX),     (Software Level),   (File Name)   (#  n/a )  Dsply Unit App
Avance MBC, (      n/a      )      ,   (Software Level),   (File Name)   (#  n/a )  ModBus Control
Avance MHB, (      n/a      )      ,   (Software Level),   (File Name)   (#  n/a )  Dsply Unit Fon
Avance HGG, (      n/a      )      ,   (Software Level),   (File Name)   (#  n/a )  Dsply Unit Fon
        < End of File>
```

8b.8.1 System Download Log

Whenever a Software Download is completed, the specific software download is recorded

- in the System Download Log that resides on the system (Display Unit)
- and in the CF Card Install Log that resides on the Compact Flash Card.

Selecting ***System Download Log*** brings up the Revision Log for the system. The log includes chronological entries for every Software Download that was completed to the system.

Note: To view currently downloaded system software, scroll to last entry in the log (<End of File>) or view the Compatibility Table, instead.

```
# System s/n ABCDXXXXXXXXX loaded by Download XXX on (day) (date) (time)
# using HPDU Softwr Loader & Svc Ver XX.XX from card [XXXX] to [XXXX}
System Version XX.XX
Avance FPC, *                          ,   (Software Level),   (File Name)   (#  n/a )  Front Panel CN
Avance PSC, (Stock Number) (RevX),     (Software Level),   (File Name)   (Serial #)  Power Controll
Avance ACB, (Stock Number) (RevX),     (Software Level),   (File Name)   (Serial #)  AnesControl B
Avance VNT, (Stock Number)  (RevX),    (Software Level),   (File Name)   (Serial #)  Vent Intface B
Avance MXR, (Stock Number) (RevX),     (Software Level),   (File Name)   (Serial #)  Electronic Mix
Avance DUB, (Stock Number) (RevX),     (Software Level),   (File Name)   (Serial #)  Dsply Unit BIO
Avance DUA, (Stock Number) (RevX),     (Software Level),   (File Name)   (#  n/a )  Dsply Unit App
Avance MBC, (       n/a       )        ,   (Software Level),   (File Name)   (#  n/a )  ModBus Control
Avance MHB, (       n/a       )        ,   (Software Level),   (File Name)   (#  n/a )  Dsply Unit Fon
Avance HGG, (       n/a       )        ,   (Software Level),   (File Name)   (#  n/a )  Dsply Unit Fon
```

Note

The Stock Number listed is for the board assembly and may not represent an orderable service item. Refer to the parts lists in Section 10 for service level stock numbers.

The Front Panel Control (FPC), Display Unit Application (DUA), the ModBus Control (MBC), the two font files (MHB and HGG) reside, along with the Display Unit BIOS (DUB), on the Display Unit CPU board.

8b.8.2 CF Card Install Log

Selecting ***CF Card Install Log*** brings up the CF (CompactFlash) Card Install Log for the software download card. The log includes chronological entries for every Software Download that was completed with the card.

8b.8.3 View Install Errors

If Software Download detects an incompatible subsystem, an error message noting the incompatible subsystem is recorded on the CF card.

```
ERROR!! INCOMPATIBLE SOFTWARE.

The software version on the CF card is not
compatible with the installed XXX subsystem.

Installed part #: (Stock Number) (Rev X), swver XX.XX
CF card part #: (Stock Number) (Rev X), swver XX.XX
```

Note: The Install Errors log includes two “screen dumps” for each occurrence of an error. The last “screen dump” includes the error message at the point where the incompatibility was detected. You can scroll up to the next “screen dump” in sequence to view the completed downloads.

Notes

9 Repair Procedures

In this section

⚠ **WARNING** To prevent fires:

- Use lubricants approved for anesthesia or O_2 equipment, such as Krytox.
- Do not use lubricants that contain oil or grease; they burn or explode in high O_2 concentrations.
- All covers used on the system must be made from antistatic (conductive) materials. Static electricity can cause fires.

⚠ Obey infection control and safety procedures. Used equipment may contain blood and body fluids.

⚠ A movable part or a removable component may present a pinch or a crush hazard. Use care when moving or replacing system parts and components.

⚠ Some internal parts have sharp edges and can cause cuts or abrasions. Use care when servicing internal components.

⚠ After repairs are completed, always perform the checkout procedure. Refer to Section 3 of this manual.

⚠ **CAUTION** Electrostatic discharge through circuit boards may damage the components on them. Wear a static control wrist strap before touching the circuit boards. Handle all circuit boards by their non-conductive edges. Use anti-static containers when transporting them.

9.1 Circuit board replacement precautions

The Aisys anesthesia system has processors on several boards. On three of these boards, information such as the machine serial number and optional ventilation modes (PCV, SIMV, and PSVPro) are stored redundantly.

During power-up, the machine serial number and installed options information stored on the boards are compared. If one board differs, information from the two agreeing boards will be written to the new board. If three boards differ (in the case of two boards replaced) the system defaults to “NO OPTIONS” and default machine serial number.

To retain the installed options, **install only one replacement board at a time**.

If multiple boards are to be installed, install the first board, load software on the new board, and power-up the machine in normal mode. Repeat this procedure for each board installation.

The following table lists the actions required after replacing printed circuit boards:

Board Name (Short Name)	**Required Action After Installation**
Display Unit CPU (DU CPU)	Load Software (see **Note**). Check / Re-Configure Machine Configurations. Affix the new Key Code and Board ID Label to Vent Casting. Preoperative Checkout.
Anesthesia Control Board (ACB)	Load Software. Check / Re-Configure Machine Configurations. User Calibrations (O2 Cell, Flow Sensor, etc.). Gas Transducer Zero. All Ventilator Calibrations. Preoperative Checkout.
Power Controller (PCB)	Load Software. Preoperative Checkout.
Ventilator Interface Board (VIB)	Load Software. User Calibrations (O2 Cell, Flow Sensor, etc.). All Ventilator Calibrations. Preoperative Checkout.
Electronic Mixer (Mixer)	Load Software. Zero Mixer Pressure Sensors. Preoperative Checkout.
All Others	Preoperative Checkout.
Note: Flash software starts loading immediately when the Download Application first boots. Do not interrupt the Flash download. Allow the download to complete before proceeding.	

9.2 How to bleed gas pressure from the machine

Before disconnecting pneumatic fittings, bleed all gas pressure from the machine.

1. Close all cylinder valves and disconnect all pipeline supplies from the source.
2. Set the system switch to On.
3. Ensure that all cylinder and pipeline pressures read zero.
4. Establish a flow for the affected gas to bleed down the pressure.
5. Set the system switch to Standby.

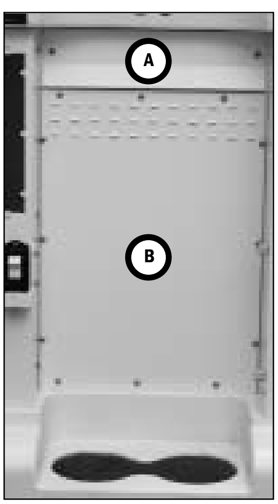
9.3 How to remove the rear panels

You must remove the rear upper panel to repair or replace many of the machine's components. To access the rear electronics enclosure, you must remove the lower access panels.

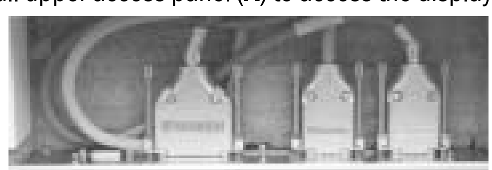
9.3.1 To remove the rear upper panel

1. Bleed all gas pressure from the machine (Section 9.2).
2. Ensure that all cylinder and pipeline pressures read zero before proceeding.
3. Disconnect all electrical cables.
4. To remove the rear panel, fully loosen the three captive screws that hold the panel in place. Remove the panel.
    - If the machine includes integrated suction, disconnect the two tube fittings from the overflow safety trap manifold.
    - If the machine includes electrical outlets, lower the panel and place it so that it does not stress the power cable.

9.3.2 To remove the lower access panels

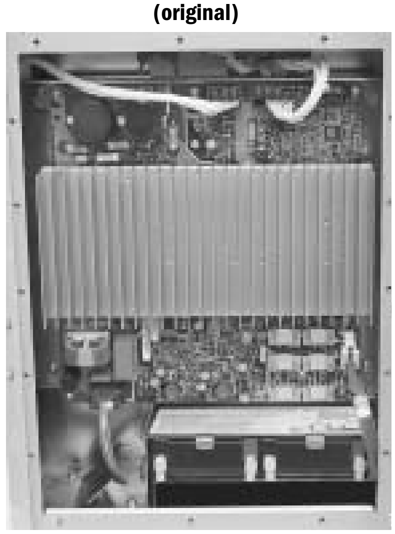


1. Disconnect the power cord from the AC mains supply.
2. Bleed all gas pressure from the machine (Section 9.2).
3. Ensure that all cylinder and pipeline pressures read zero before proceeding.
4. If present, remove the inboard cylinders.
5. Remove the small upper access panel (**A**) to access the display connector board.

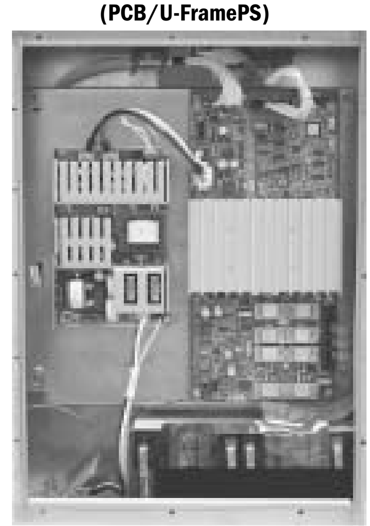


6. Remove the large lower access panel (**B**) to access the electrical enclosure.

(original)



(PCB/U-FramePS)



9.4 How to remove the tabletop

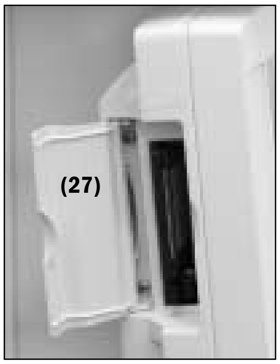
The tabletop is held in place with five captive screws along the periphery of the pan assembly (accessed from below the rim of the tabletop).

- One screw (**A**) is in a deep recess at the right-rear corner of the tabletop.
- Two screws (**B**) are at the front of the tabletop: one screw is at the right corner of the tabletop, one is near the O_2 Flush button.
- To access the remaining two screws (**C**), you must remove the ABS: one screw is at the left corner of the tabletop, one is near the APL Valve.

9.5 Servicing the Display Unit (DU)

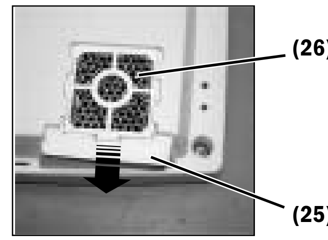
Note To service the HPDU, refer to Section 9.6.

The item numbers appearing in parenthesis in this section refer to items in the parts list in Section 10.7.



The fan filter (26) and the access door (27) to the PCMCIA interface can be replaced with the Display Unit in place.

To replace the filter, slide the filter capsule (25) downward to remove it from the Display Unit.

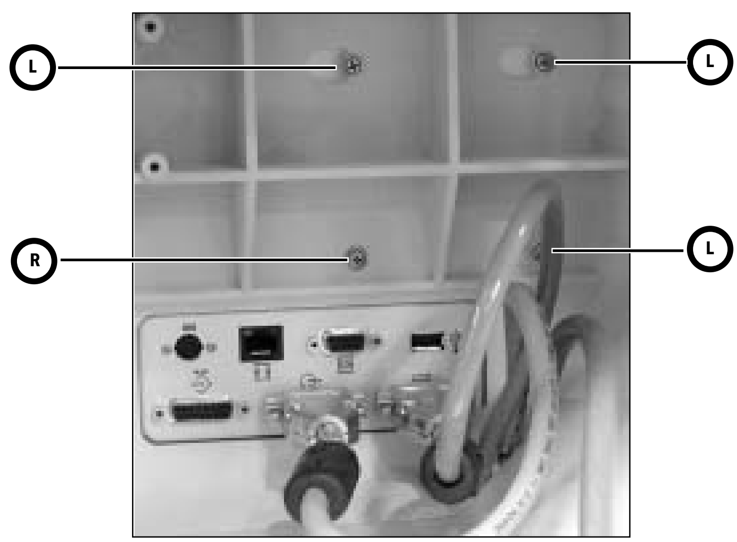


To service other components of the Display Unit, you must first remove the Display Unit from the machine.

9.5.1 Remove the Display Unit

The Display Unit is held in place with four screws: three screws fit into keyhole slots and do not have to be fully removed; the fourth screw secures the Display Unit to the front bezel and must be removed to free the Display Unit from the machine.

1. Open the rear access door directly behind the Display Unit.
2. Loosen (**L**) the top two and the bottom-right mounting screws.
3. Remove (**R**) the lower-left mounting screw.

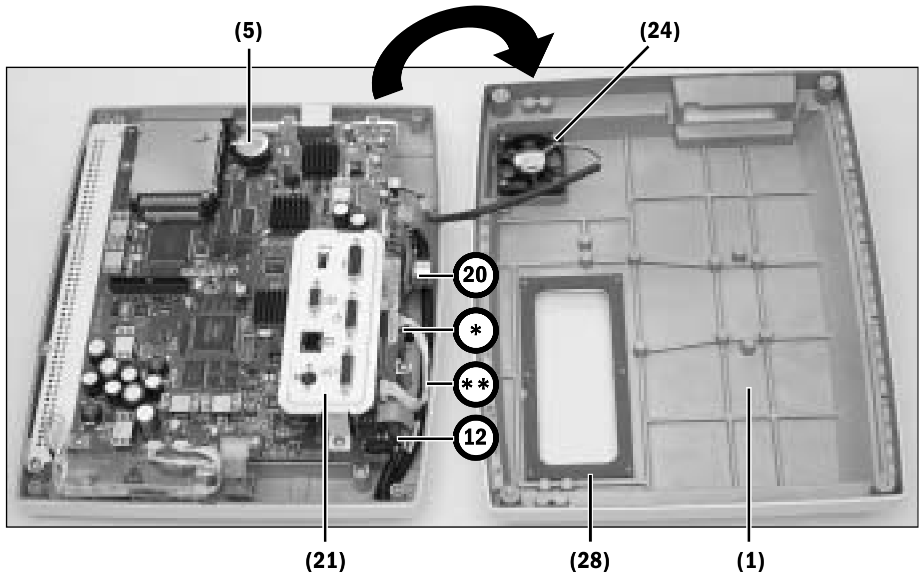


4. Place a protective pad on the tabletop.
5. From the front of the machine, slide the Display Unit toward the center of the machine to free it from the keyhole slots.
6. Lower the Display Unit face down on the protective pad.
7. Remove the cables from the rear connector panel.

9.5.2 Disassemble the Display Unit

Place the Display Unit face down on an anti-static pad. Before removing the rear enclosure, ensure that the release tabs on the PCMCIA frame are fully depressed.

1. Loosen (**L**) the four captive screws at each corner of the rear enclosure.
2. Lift the rear enclosure slightly and pivot it away from the lower enclosure at the bottom side of the Display Unit.



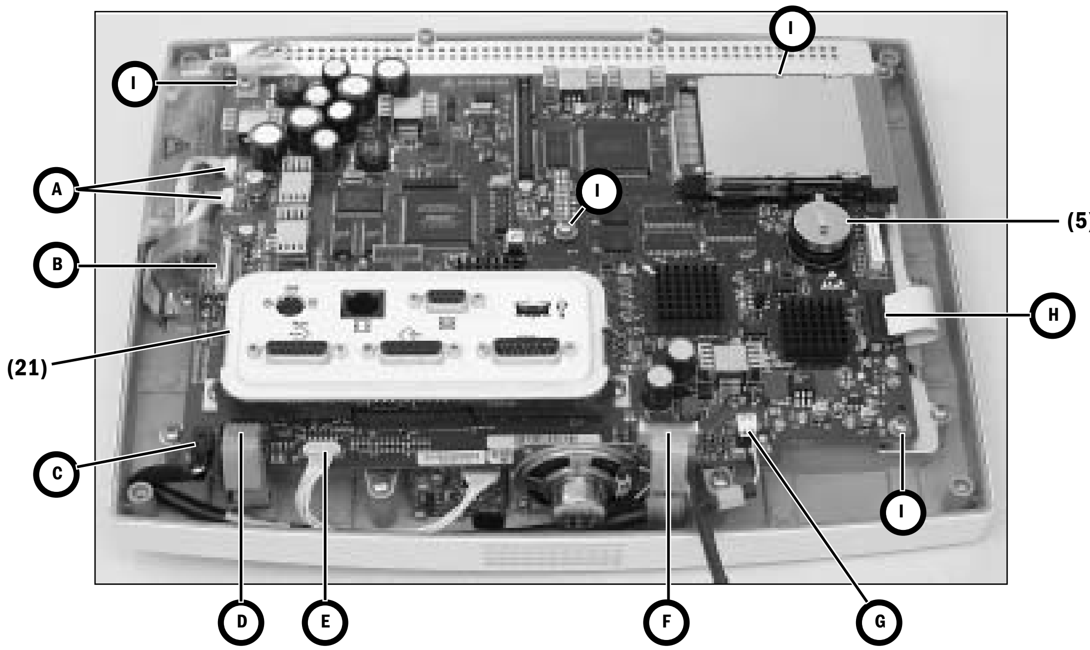
At this point, you can replace the following items (the item numbers refer to the parts list in Section 10.7):

- the **fan** (24)
- the **connector panel assembly** (21)
- the **encoder assembly** (12)
- the **IRDA board** (*) or **IRDA board harness** (**)
  (First production DUs included an IRDA board that is no longer used. System software does not support the IRDA board, which is now obsolete.)
- the **battery** (5)
- the **speaker** (20) – To access the mounting screws for the speaker, you must first remove the ten screws that hold the mounting plate to the front enclosure so that you ¸can raise the bottom edge of the assembly slightly – Refer to section 9.5.4.)
- the **rear enclosure** (1) – You can transfer the captive screws to the new enclosure. However, the **gasket** (28) is held in place with adhesive. When replacing the rear enclosure, also include a new gasket.

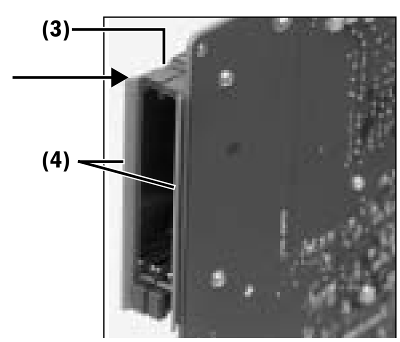
To replace the remaining items requires further disassembly.

9.5.3 To replace the CPU board

1. Remove the **connector panel assembly** (21) — two screws.
2. Disconnect the following cables:
   - Inverter harnesses (**A**)
   - Membrane switch flex-cable at ZIF (zero insertion force) connector (**B**)
   - Speaker cable (**C**)
   - Encoder assembly cable (**D**)
   - If present, IRDA board cable (**E**)
   - Membrane switch flex-cable at ZIF (zero insertion force) connector (**F**)
   - Fan cable (**G**)
   - LCD cable (**H**)



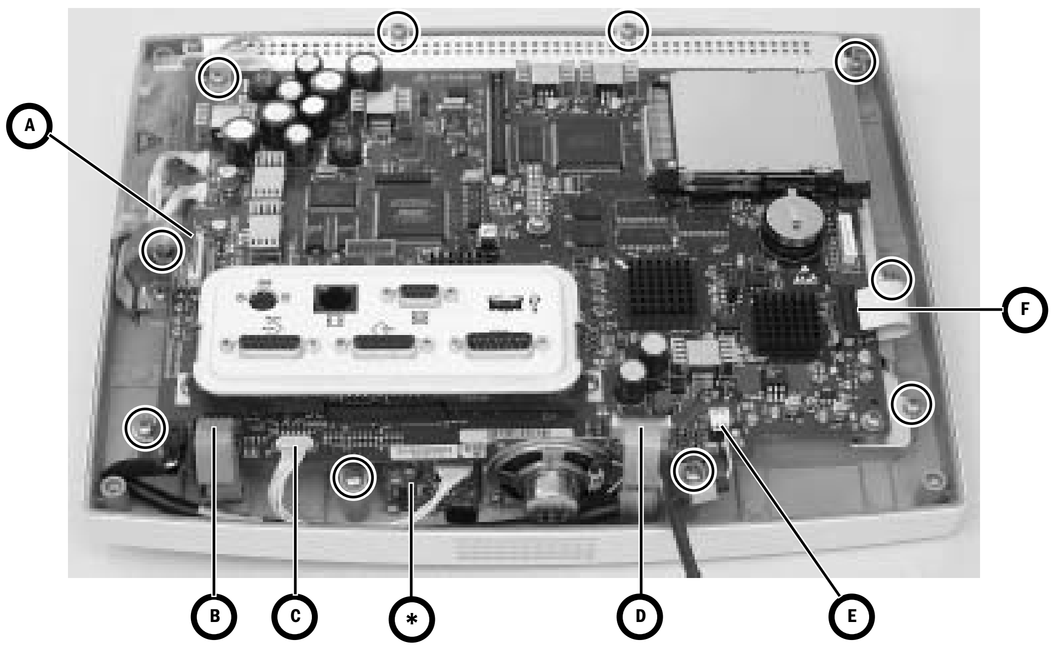
3. Remove the remaining four screws (**I**) that hold the CPU board to the mounting plate.
4. Remove the CPU board from the mounting plate.
5. If you are **replacing the PCMCIA frame** (3) on an existing CPU board (remove four screws on back of CPU board), you must also apply new gaskets (4) to the frame. Align the ends of the gaskets with the top edge of the frame.
6. Transfer the battery (5) to the new CPU board.



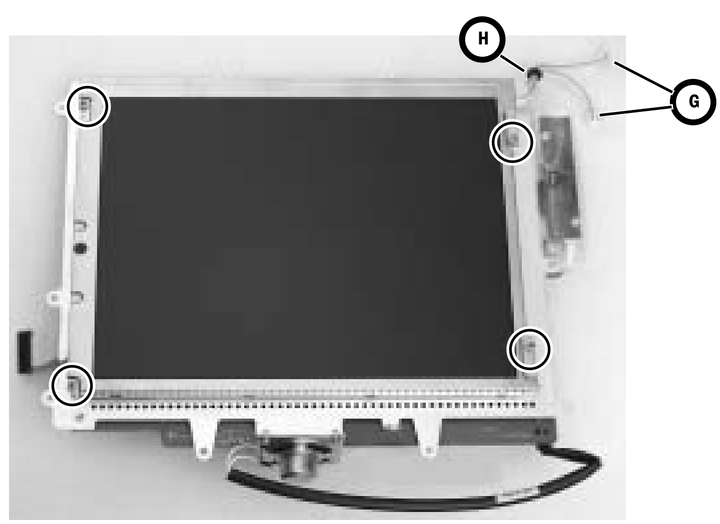
7. Reassemble in reverse order.
8. Download latest software (Section 8a.6).
9. Reconfigure the Machine Configurations (Install/Setups).
10. Affix a new Key Code and Board ID label to the Vent casting.

9.5.4 To replace the LCD display

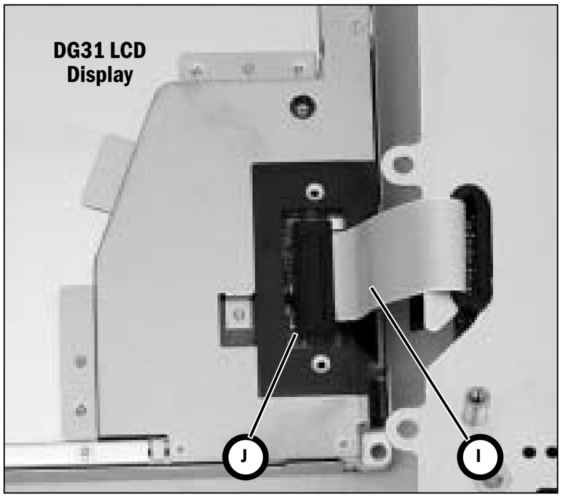
1. Disconnect the following cables:
   - Membrane switch flex-cable at ZIF (zero insertion force) connector (**A**)
   - Encoder assembly cable (**B**)
   - If present, IRDA Interface cable (**C**) — remove IRDA Interface board (*)
   - Membrane switch flex-cable at ZIF (zero insertion force) connector (**D**)
   - Fan cable (**E**)
   - LCD cable (**F**)
2. Remove the ten screws (**circled**) that hold the mounting plate to the front enclosure.

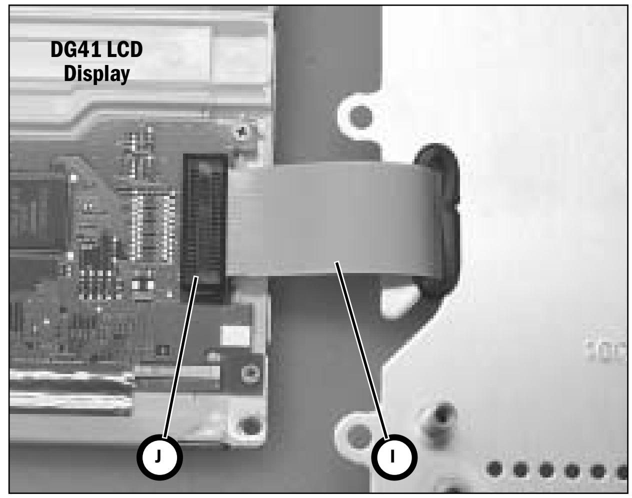


3. Remove the mounting plate assembly from the front enclosure.
4. Disconnect the backlight harnesses (**G**) from the inverter boards.
5. Slide the grommet (**H**) out of the mounting plate slot (transfer to new LCD).
6. Remove the four screws (**circled**) that hold the LCD to the mounting plate.



7. Lift the left side of the LCD display slightly away from the mounting plate to pull some of the display ribbon cable (**I**) to the top side of the plate. Flip the LCD over to the left of the assembly.
8. Disconnect the display ribbon cable (**J**).





9. Reassemble in reverse order.

   Note: When replacing the LCD, pull the excess ribbon cable to the bottom side of the plate as you lower the LCD on to the plate. For the backlight harness grommet (**H**), ensure that the slit in the grommet faces toward the inside of the keyhole.

9.5.5 To replace the backlights

Note Early production Avance Display Units (DU) included a DG31 LCD display. Subsequent display units (and the HPDU) include a DG41 LCD display. The backlight in the DG31 display is not compatible with the DG41 display.

It is impossible to determine which LCD is installed without disassembling the Display Unit. The serial numbers reference below are approximate, some machines near the cutoffs may have either the DG31 or the DG41 installed.

- DG31 Backlight Kit (Avance serial numbers less than ABNG00380)
- DG41 Backlight Kit (Avance serial numbers greater than ABNH00400)

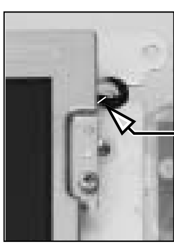
To replace the backlights in a DG41 display, refer to Section 9.6.6.

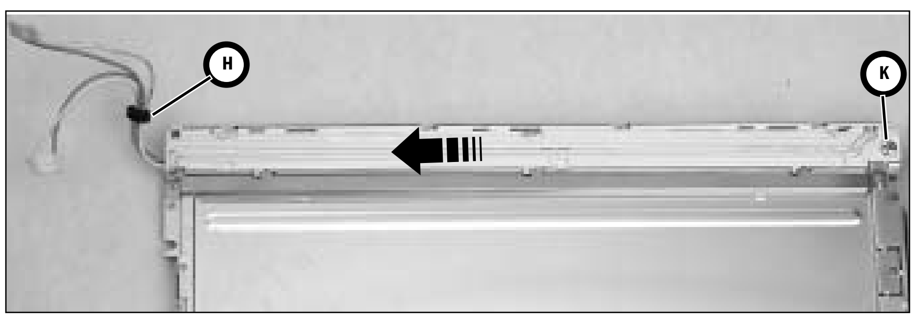
To replace the backlights in a DG31 display, continue below.

Note: When replacing a backlight or a backlight inverter, you must replace both inverters and the backlight assembly found in the Backlight Kit.

The backlight replacement kit for a DG31 display includes a backlight assembly (with two backlights) and two inverters with mounting hardware. To replace the backlight assembly follow the procedure in Section 9.5.4 to gain access to the assembly. To replace the inverters, follow the procedure in the next section.

1. Remove the one screw (**K**) that holds the backlight assembly to the LCD.
2. Slide the backlight assembly to the left to free it from the retaining tabs and then lift it out of the holder.





3. Transfer the grommet (**H**) to the new backlight assembly.
4. Reassemble in reverse order.

9.5.6 To replace the Inverters

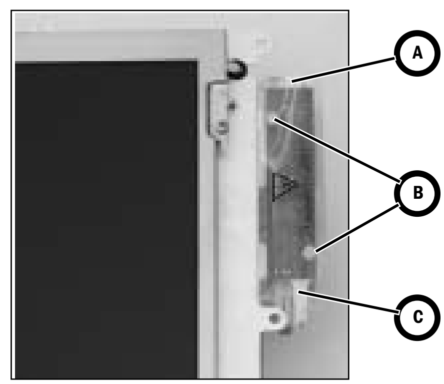
Note: When replacing a backlight or a backlight inverter, you must replace both inverters and the backlight assembly found in the Backlight Kit.

The Display Unit includes two inverters (one for each backlight).

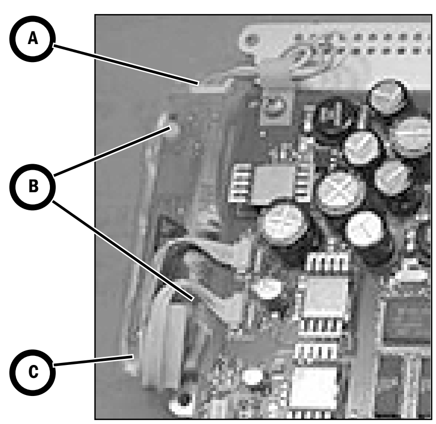
The inverters “sandwich” the mounting plate and use it as a heatsink. Follow the procedure in Section 9.5.4 to gain access to the inverters. Replace one inverter at a time.

1. Disconnect the backlight cable (**A**) from the inverter.
2. Remove the two Nylon screws (**B**) that hold the inverter to the backplate.
3. Slide the inverter out of the sleeve and disconnect it from the CPU harness (**C**).
4. Reassemble in reverse order.

The “front” inverter



The “rear” inverter



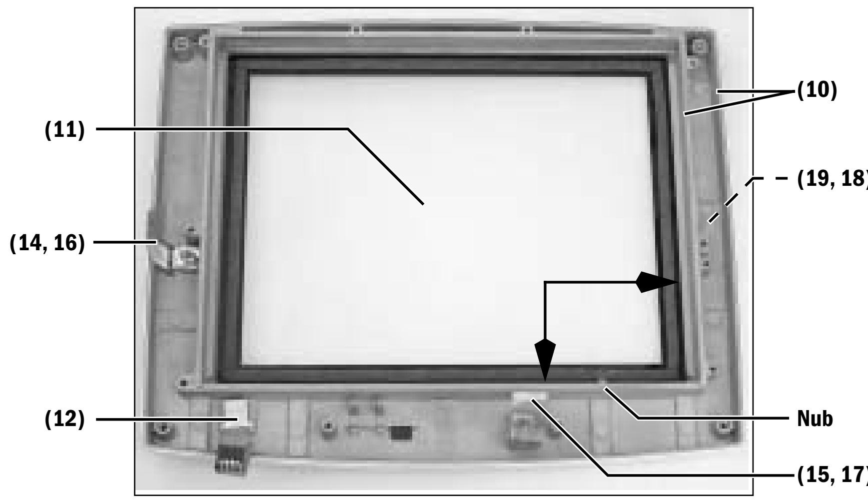
9.5.7 To replace the front enclosure or components

Disassemble the Display Unit following procedures in the previous sections to the point where you have removed the mounting plate assembly from the front enclosure.

If you are replacing the front enclosure, you can transfer the encoder (12) assembly to the new enclosure; but, you must build up the replacement enclosure with:

- a new window (11)
- new membrane switches — right-side (14), lower (15), left-side spacer (19)
- new keypads - right-side (16), lower (17), left-side blank (18)
- new EMC gasket (10)

If you are replacing a keypad or a membrane switch, you must replace both items.

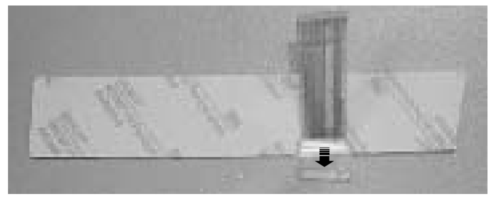


To replace the window

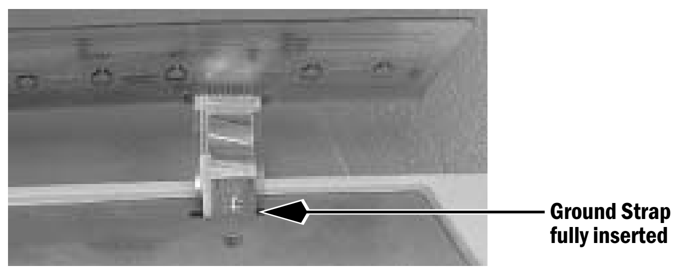
1. Place the front enclosure face up on a flat surface.
2. Press down on one corner of the window to free it from the enclosure.
3. Work your way around the window until you can get a hold of it from the back.
4. Slowly pry the window from the enclosure.
5. Place the front enclosure face down on a flat surface, taking care not to damage the encoder.
6. Remove any remaining residue from the mounting area; clean with isopropyl alcohol.
7. Remove the inside protective material from the front of the window.
8. Peel the front outside frame of the release liner.
9. Lower the window straight down in the enclose, noting the notch in the window and the matching nub on the enclosure.
10. Before seating the window, position it in contact with the bottom and right sides of the frame (see arrows) so that the larger gap between the window and the enclosure is at the top and left edges (as viewed from behind).
11. Remove the protective film from the back side of the window.

To replace a membrane switch and keypad

1. Remove the screw that attaches the grounding strap to the enclosure.
2. Pry the membrane switch and keypad from the enclosure.
3. Remove any remaining residue from the mounting area; clean with isopropyl alcohol.
4. Remove the backing from the membrane. Be sure to remove the small backing below the flex cable. Be careful not to allow the ribbon cable to adhere to the backing.



5. Insert the flex cable and ground strap through the slot in the enclosure. Ensure that all of the ground strap passes through the slot an does not remain folded over under the membrane.



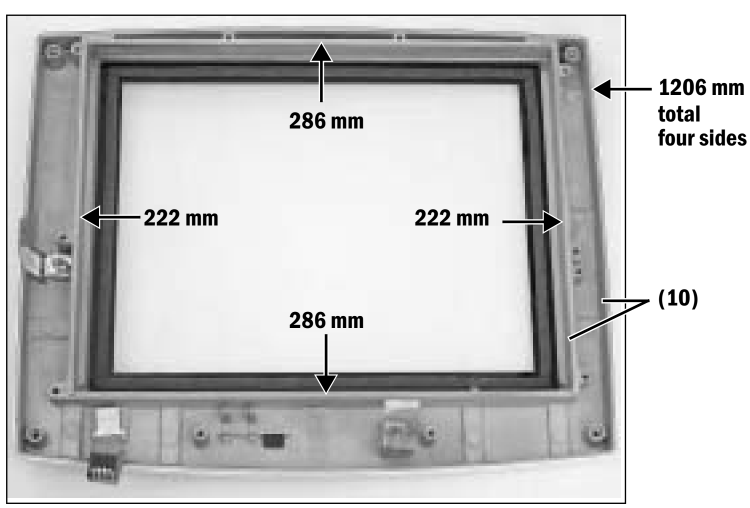
6. Carefully lower the membrane straight down to the enclosure. Seat the membrane in place.
7. Remove the backing from the keypad and install it over the membrane switches.
8. Attach the ground strap to the enclosure.

To install the EMI gasket

To fully seal the Display Unit enclosure, you will need approximately 2.3 meters of EMC gasket (10). Cut the gasket into five strips shown below.

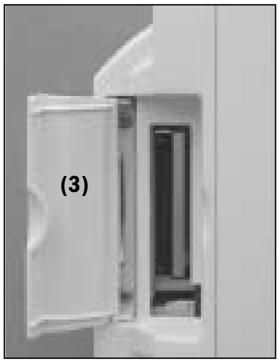
Insert a continuous length of gasket in the outside grove of the enclosure (sparingly apply "Super Glue Gel" to the channels near the corners before installing the gasket).

Insert individual lengths of gasket in the inside grove around the window (sparingly apply "Super Glue Gel" to the channels near the corners before installing the gasket).



9.6 Servicing the High Performance Display Unit (HPDU)

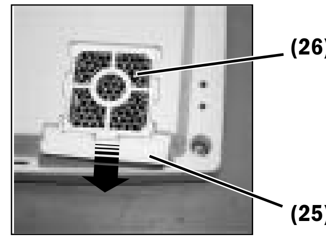
Note To service the DU, refer to Section 9.5.



The item numbers appearing in parenthesis in this section refer to items in the parts list in Section 10.8.

The fan filter (26) and the access door (3) to the PCMCIA interface can be replaced with the Display Unit in place.

To replace the filter, slide the filter capsule (25) downward to remove it from the Display Unit.

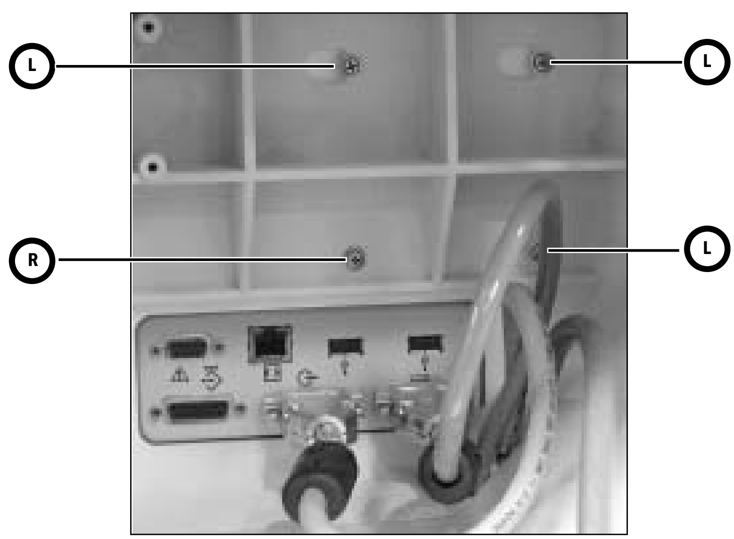


To service other components of the Display Unit, you must first remove the Display Unit from the machine.

9.6.1 Remove the Display Unit

The Display Unit is held in place with four screws: three screws fit into keyhole slots and do not have to be fully removed; the fourth screw secures the Display Unit to the front bezel and must be removed to free the Display Unit from the machine.

1. Open the rear access door directly behind the Display Unit.
2. Loosen (**L**) the top two and the bottom-right mounting screws.
3. Remove (**R**) the lower-left mounting screw.

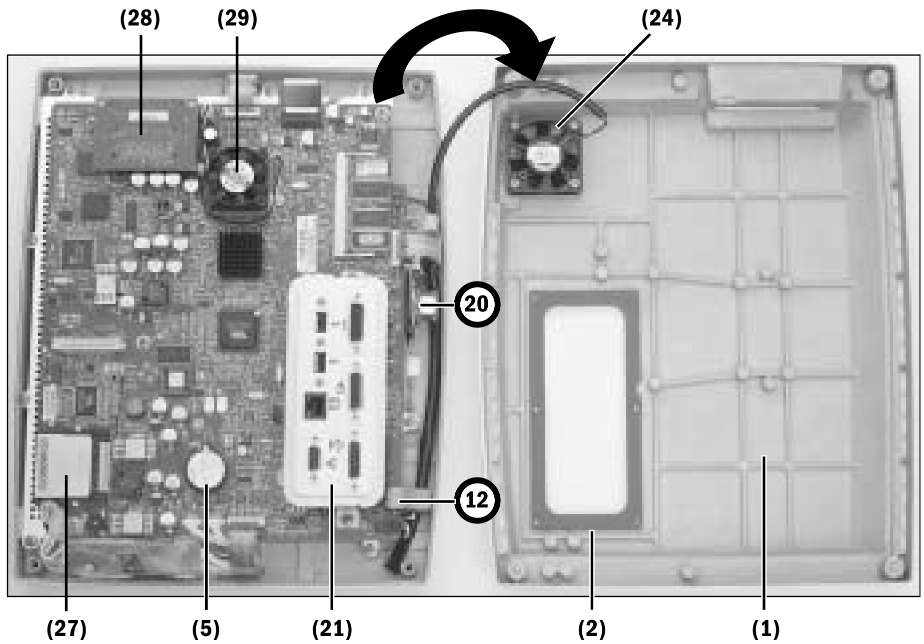


4. Place a protective pad on the tabletop.
5. From the front of the machine, slide the Display Unit toward the center of the machine to free it from the keyhole slots.
6. Lower the Display Unit face down on the protective pad.
7. Remove the cables from the rear connector panel.

9.6.2 Disassemble the Display Unit

Place the Display Unit face down on an anti-static pad.

1. Loosen (**L**) the four captive screws at each corner of the rear enclosure.
2. Lift the rear enclosure slightly and pivot it away from the lower enclosure at the bottom side of the Display Unit.



At this point, you can replace the following items (The item numbers refer to the parts list in Section 10.8):

- the **internal Compact Flash card** (27)
- the **external Compact Flash Kit** (28)
- the **fan** (24) – for the HPDU this is a 12-volt fan
- the **connector panel assembly** (21)
- the **encoder assembly** (12)
- the **battery** (5)
- the **speaker** (20) – (To access the mounting screws for the speaker, you must first remove the ten screws that hold the mounting plate to the front enclosure so that you can raise the bottom edge of the assembly slightly – Refer to section 9.6.5.)
- the **rear enclosure** (1) – You can transfer the captive screws to the new enclosure. However, the **gasket** (2) is held in place with adhesive. When replacing the rear enclosure, also include a new gasket.

To replace the remaining items requires further disassembly.

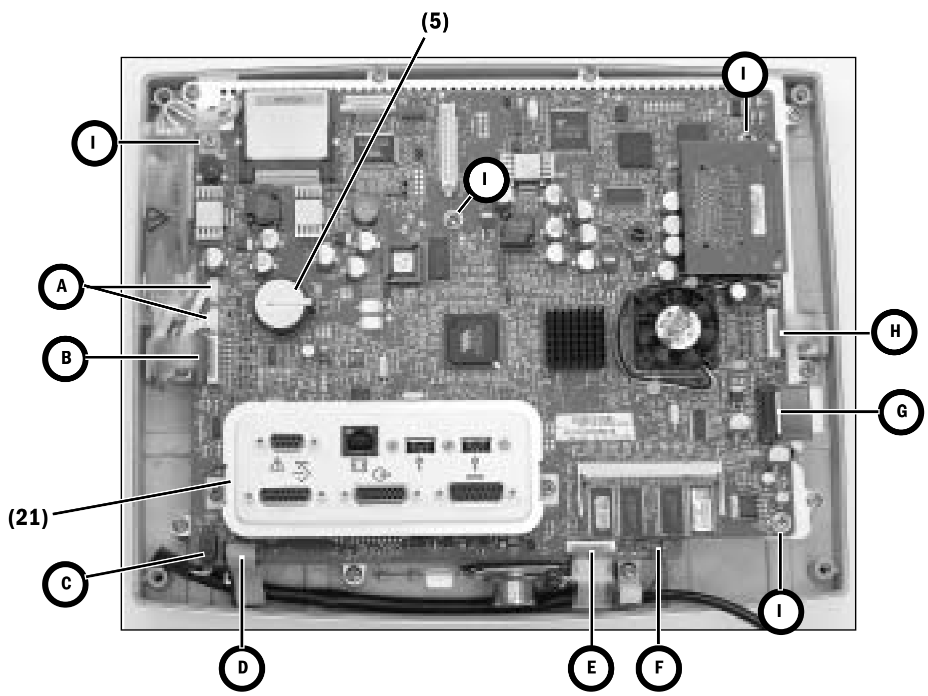
9.6.3 CPU Fan

⚠ **CAUTION**: Do not remove the heatsink from the CPU board.

1. Note the orientation of the fan harness.
   Disconnect the fan harness from the CPU board.
2. Remove the fan (29) from the CPU heatsink, leaving the heatsink in place.
3. Remove the heatsink (discard) from the replacement fan assembly.
4. Noting the orientation of the fan harness, secure the fan to the CPU heatsink.
5. Connect the fan harness to the CPU board.

9.6.4 To replace the CPU board

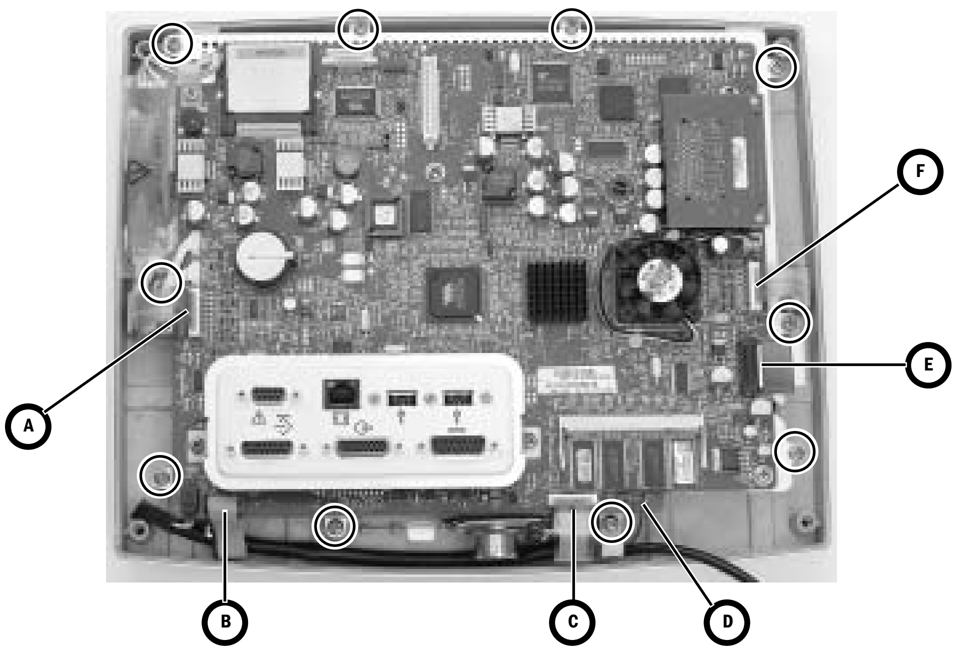
1. Remove the **connector panel assembly** (21) — two screws.
2. Disconnect the following cables:
   - Inverter harnesses (**A**)
   - Right membrane switch flex-cable at ZIF (zero insertion force) connector (**B**)
   - Speaker cable (**C**)
   - Encoder assembly cable (**D**)
   - Lower membrane switch flex-cable at ZIF (zero insertion force) connector (**E**)
   - Fan cable (**F**)
   - LCD cable (**G**)
   - Left membrane switch flex-cable at ZIF (zero insertion force) connector (**H**)



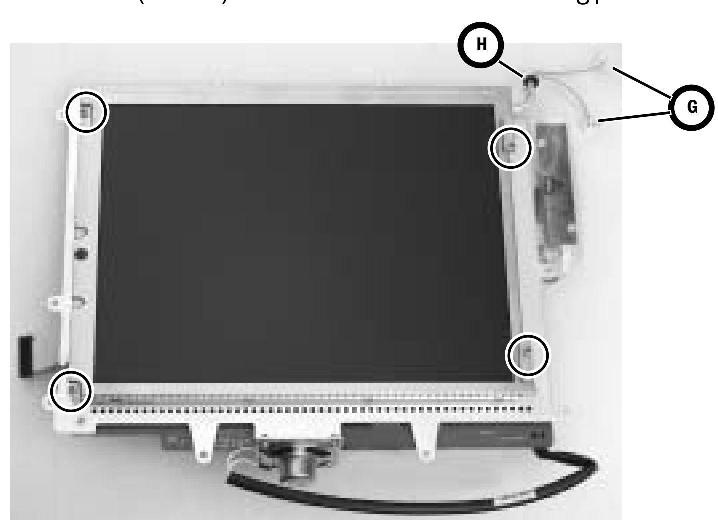
3. Remove the remaining four screws (**I**) that hold the CPU board to the mounting plate.
4. Remove the CPU board from the mounting plate.
5. Transfer the battery (5) to the new CPU board.
6. Reassemble in reverse order.
7. Download the latest software (Section 8a.6).
8. Reconfigure the Machine Configurations (Install/Setups).
9. Affix a new Key Code and Board ID label to the Vent casting.

9.6.5 To replace the LCD display

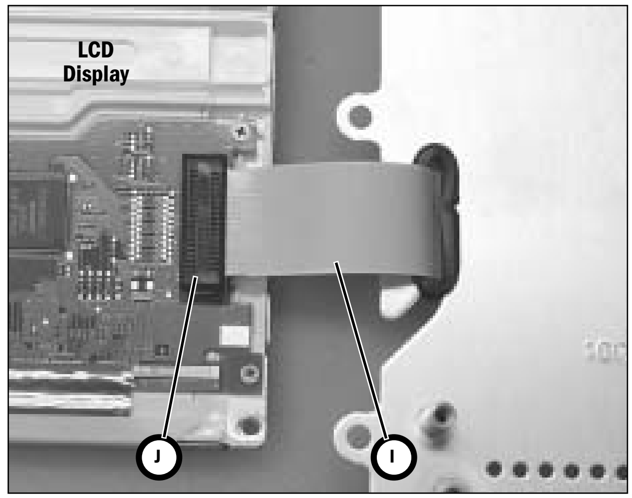
1. Disconnect the following cables:
   - Right membrane switch flex-cable at ZIF (zero insertion force) connector (**A**)
   - Encoder assembly cable (**B**)
   - Lower membrane switch flex-cable at ZIF (zero insertion force) connector (**C**)
   - Fan cable (**D**)
   - LCD cable (**E**)
   - Left membrane switch flex-cable at ZIF (zero insertion force) connector (**F**)
2. Remove the ten screws (**circled**) that hold the mounting plate to the front enclosure.



3. Remove the mounting plate assembly from the front enclosure.
4. Disconnect the backlight harnesses (**G**) from the inverter boards.
5. Slide the grommet (**H**) out of the mounting plate slot (transfer to new LCD).
6. Remove the four screws (**circled**) that hold the LCD to the mounting plate.



7. Lift the left side of the LCD display slightly away from the mounting plate to pull some of the display ribbon cable (**I**) to the top side of the plate. Flip the LCD over to the left of the assembly.
8. Disconnect the display ribbon cable (**J**).



9. Reassemble in reverse order.

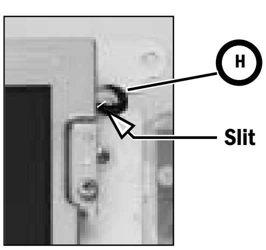
   Note: When replacing the LCD, pull the excess ribbon cable to the bottom side of the plate as you lower the LCD on to the plate. For the backlight harness grommet (**H**), ensure that the slit in the grommet faces toward the inside of the keyhole.

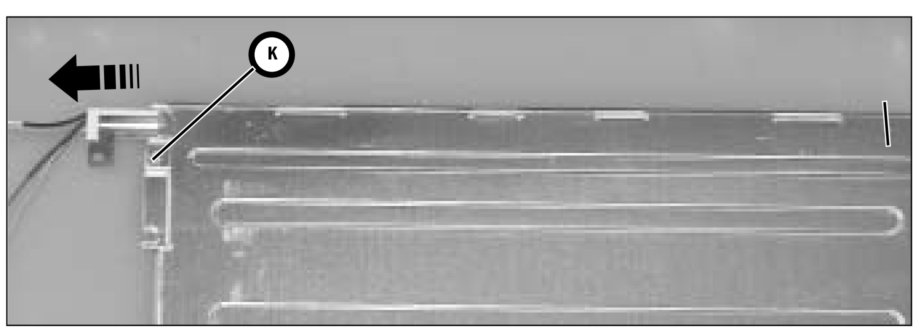
9.6.6 To replace the backlights

Note: When replacing a backlight or a backlight inverter, you must replace both inverters and the backlight assembly found in the Backlight Kit.

The backlight replacement kit includes a backlight assembly (with two backlights) and two inverters with mounting hardware. To replace the backlight assembly follow the procedure in Section 9.5.4 to gain access to the assembly. To replace the inverters, follow the procedure in the next section.

1. Remove the one screw (**K**) that holds the backlight assembly to the LCD.
2. Slide the backlight assembly to the left to free it from the retaining tabs and then lift it out of the holder.





3. Transfer the grommet (**H**) to the new backlight assembly.
4. Reassemble in reverse order.

9.6.7 To replace the Inverters

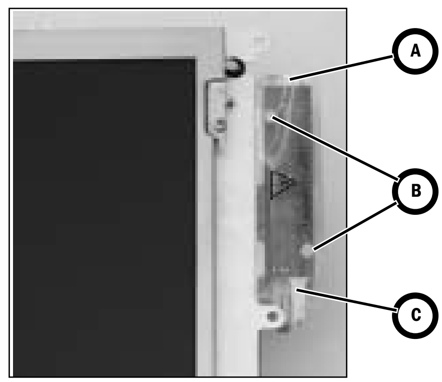
Note: When replacing a backlight or a backlight inverter, you must replace both inverters and the backlight assembly found in the Backlight Kit.

The Display Unit includes two inverters (one for each backlight).

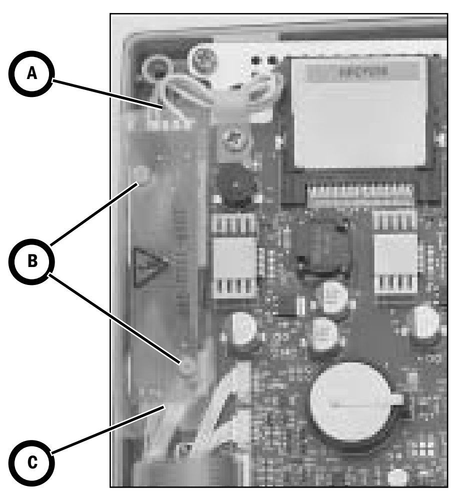
The inverters “sandwich” the mounting plate and use it as a heatsink. Follow the procedure in Section 9.6.5 to gain access to the inverters. Replace one inverter at a time.

1. Disconnect the backlight cable (**A**) from the inverter.
2. Remove the two Nylon screws (**B**) that hold the inverter to the backplate.
3. Slide the inverter out of the sleeve and disconnect it from the CPU harness (**C**).
4. Reassemble in reverse order.

The “front” inverter



The “rear” inverter



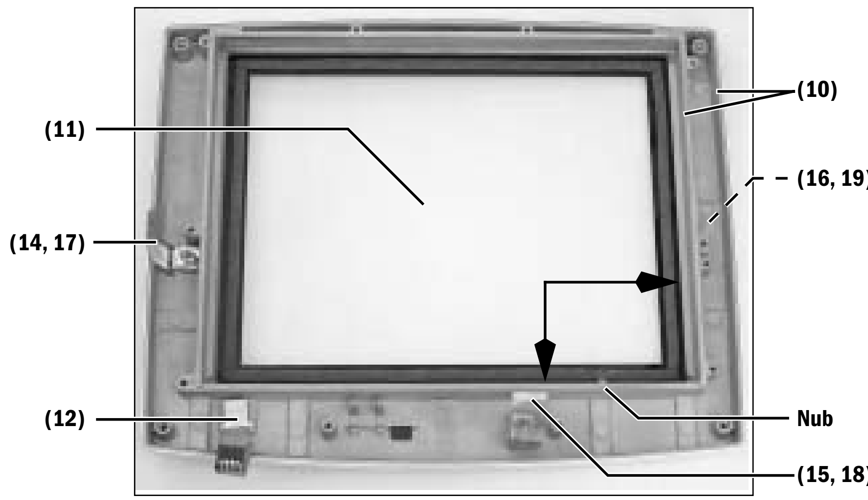
9.6.8 To replace the front enclosure or components

Disassemble the Display Unit following procedures in the previous sections to the point where you have removed the mounting plate assembly from the front enclosure.

If you are replacing the front enclosure, you can transfer the encoder (12) assembly to the new enclosure; but, you must build up the replacement enclosure with:

- a new window (11)
- new membrane switches — right-side (14), lower (15), left-side spacer (16)
- new keypads - right-side (17), lower (18), left-side blank (19)
- new EMC gasket (10)

If you are replacing a keypad or a membrane switch, you must replace both items.

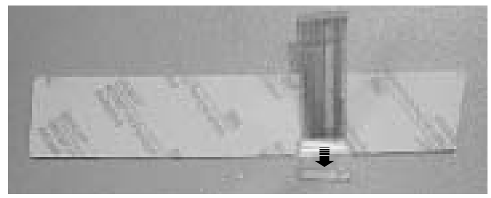


To replace the window

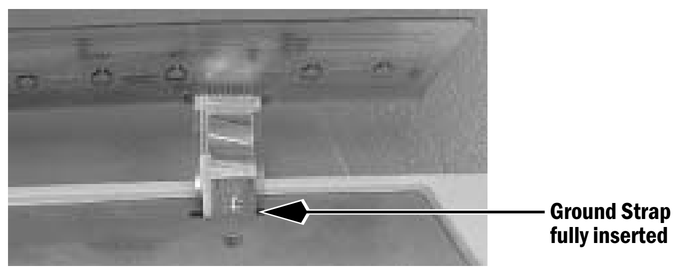
1. Place the front enclosure face up on a flat surface.
2. Press down on one corner of the window to free it from the enclosure.
3. Work your way around the window until you can get a hold of it from the back.
4. Slowly pry the window from the enclosure.
5. Place the front enclosure face down on a flat surface, taking care not to damage the encoder.
6. Remove any remaining residue from the mounting area; clean with isopropyl alcohol.
7. Remove the inside protective material from the front of the window.
8. Peel the front outside frame of the release liner.
9. Lower the window straight down in the enclose, noting the notch in the window and the matching nub on the enclosure.
10. Before seating the window, position it in contact with the bottom and right sides of the frame (see arrows) so that the larger gap between the window and the enclosure is at the top and left edges (as viewed from behind).
11. Remove the protective film from the back side of the window.

To replace a membrane switch and keypad

1. Remove the screw that attaches the grounding strap to the enclosure.
2. Pry the membrane switch and keypad from the enclosure.
3. Remove any remaining residue from the mounting area; clean with isopropyl alcohol.
4. Remove the backing from the membrane. Be sure to remove the small backing below the flex cable. Be careful not to allow the ribbon cable to adhere to the backing.



5. Insert the flex cable and ground strap through the slot in the enclosure. Ensure that all of the ground strap passes through the slot an does not remain folded over under the membrane.



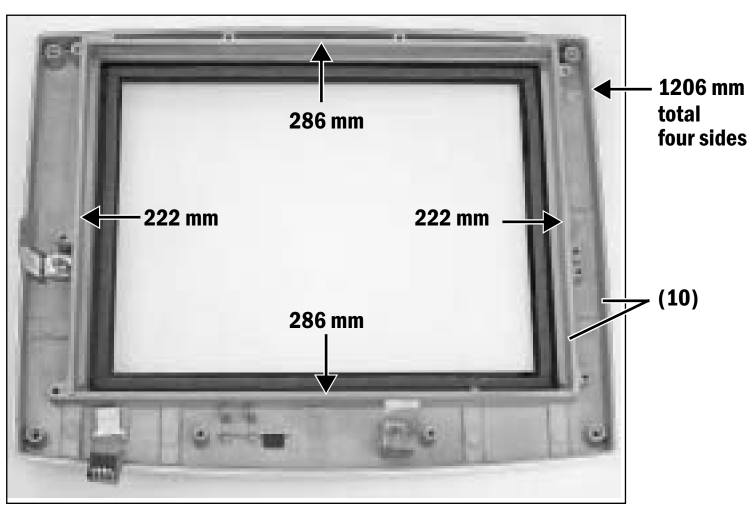
6. Carefully lower the membrane straight down to the enclosure. Seat the membrane in place.
7. Remove the backing from the keypad and install it over the membrane switches.
8. Attach the ground strap to the enclosure.

To install the EMI gasket

To fully seal the Display Unit enclosure, you will need approximately 2.3 meters of EMC gasket (10). Cut the gasket into five strips shown below.

Insert a continuous length of gasket in the outside grove of the enclosure (sparingly apply "Super Glue Gel" to the channels near the corners before installing the gasket).

Insert individual lengths of gasket in the inside grove around the window (sparingly apply "Super Glue Gel" to the channels near the corners before installing the gasket).

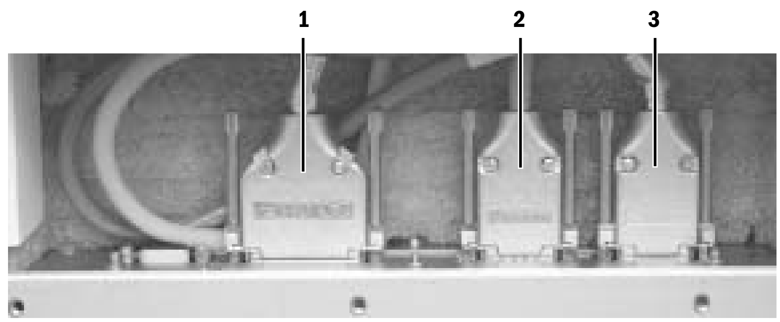


9.7 Replacing the Display and MGAS cables

To access the connections at the Display Connector board, remove the small access panel at the rear of the machine (Section 9.3.2).

The top side of the Display Connector board accepts the following cables:

- Airway Module (MGAS) Power Supply board (**1**).
- System Signal Interface to Display Unit (**2**).
- System Power Interface to Display Unit (**3**).

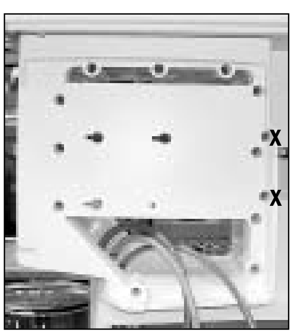


To replace any of these cables, you must remove the oxygen partition that surrounds the MGAS enclosure and MGAS power supply.

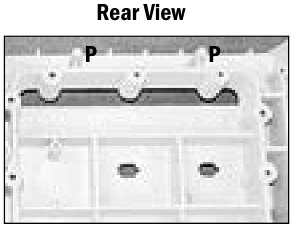
9.7.1 Remove the MGAS oxygen partition

1. Remove the rear panel (Section 9.3.1).
2. Remove the MGAS (Airway) module.
3. Remove the MGAS module guide: three screws from outside of machine, two screws at MGAS power supply box inside machine (Section 10.22.17).
4. Remove the Display Unit (Section 9.5.1).
5. From the front of the machine, remove the 11 screws that hold the oxygen partition to the front bezel. Do not remove the two screw (**X**) that hold the front bezel to the vertical support of the vaporizer manifold. When replacing the partition, position it over the two locator pins (**P**) at the top of the bezel opening.
6. Remove the foam plug from under the pan.
7. Replace the cables as necessary.
8. When replacing the partition, ensure that cable are positioned in their respective retaining grooves and that they are long enough to reach the connectors without stressing the cable. Be careful not to pinch the task light harness.
9. Reassemble in reverse order.

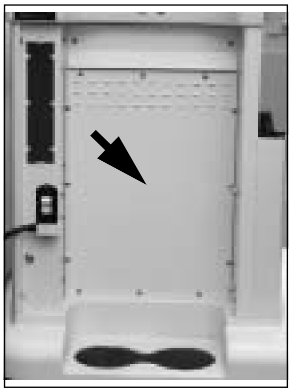
Front View



Rear View



9.8 Servicing the lower electrical enclosure components



The lower electrical enclosure includes the following components (Section 10.9:

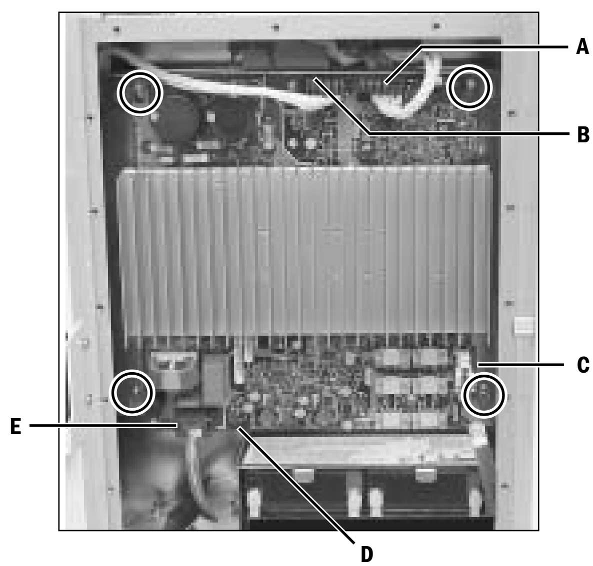
- the Power Controller board
- the Anesthesia Control board
- the Display Connector board
- the backup batteries and the lower enclosure fan.

To replace these components, remove the large access panel at the rear of the machine (Section 9.3). To replace the Display Connector board, also remove the small access panel.

9.8.1 Power Controller board (original)

The replacement Power Controller board includes the mounting plate.

1. Disconnect the cables coming from the following components:
   - the Display Connector board (**A**),
   - the Anesthesia Control board (**B**),
   - the batteries (**C**),
   - the fan (**D**),
   - the line filter (**E**).

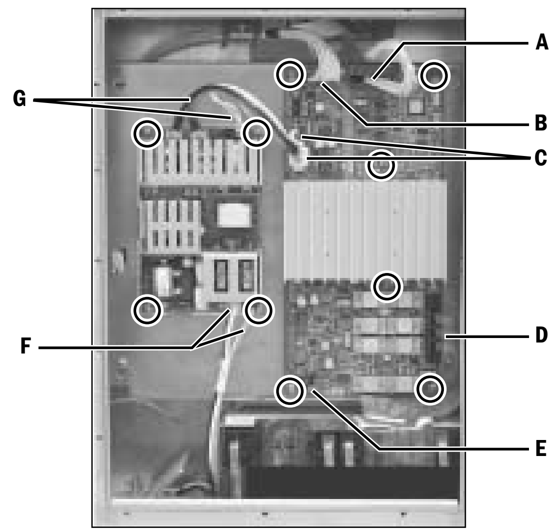


2. Loosen the four screws (**circled**) that hold the Power Controller mounting plate.
3. Lift the Power Controller assembly slightly to release it from the keyhole slots.
4. To replace the Power Controller assembly, reassemble in reverse order.
5. Load Software.

9.8.2 Power Controller board and Universal Power Supply

To replace the Power Controller board:

1. Disconnect the cables coming from the following components:
   - the Display Connector board (**A**),
   - the Anesthesia Control board (**B**),
   - the Power Supply (**C**).
   - the batteries (**D**),
   - the fan (**E**),

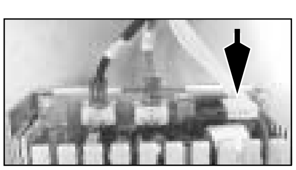


2. Remove the four lower screws (**circled**) that hold the Power Controller board to the mounting plate.
3. Loosen the two upper screws (**keyhole**) and remove the Power Controller board.
4. To replace the Power Controller board, reassemble in reverse order.
5. Load Software.

To replace the power supply (U-Frame) or to provide access to the Anesthesia Control board:

6. Disconnect all the cables listed above, except the cable between the Power Supply (**G**) and the Power Controller board (**C**).
7. Loosen the four screws (**at each corner**) that hold the PCB/PS mounting plate.
8. Lift the PCB/PS assembly slightly to release it from the keyhole slots.

To replace the power supply:



1. Disconnect the output cable (**G**) from the power supply.
   - Note position of control connector when reconnecting harness.
2. From the back of the mounting plate, remove the four screws (**circled**) that hold the power supply to the mounting plate.
3. To replace the Power Supply, reassemble in reverse order.

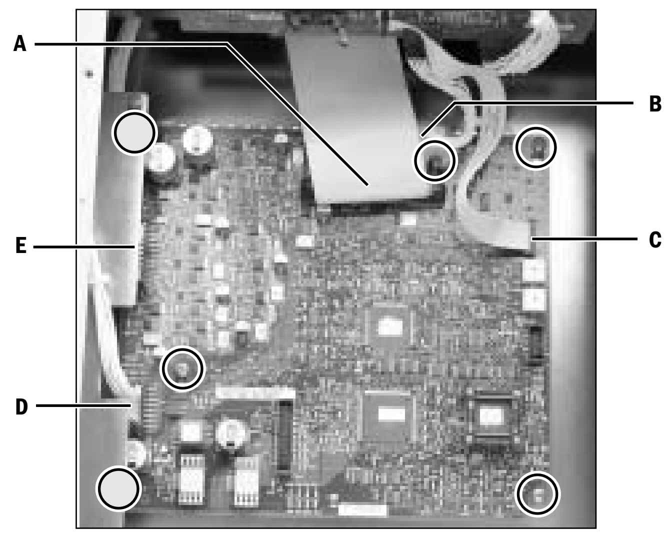
9.8.3 Anesthesia Control board

To replace the Anesthesia Control board, first remove

- the Power Controller board (Section 9.8.1)
- or the PCB/PS assembly (Section 9.8.2).

Then, follow the procedure below:

1. Disconnect the cables coming from the following components:
   - the large ribbon cable from the Pan Connector board (**A**),
   - the harness from the Display Connector board (**B**),
   - the small ribbon cable from the Display Connector board (**C**),
   - the harness from the Power Controller board (**D**),
   - the harness from the Pan Connector board (**E**).



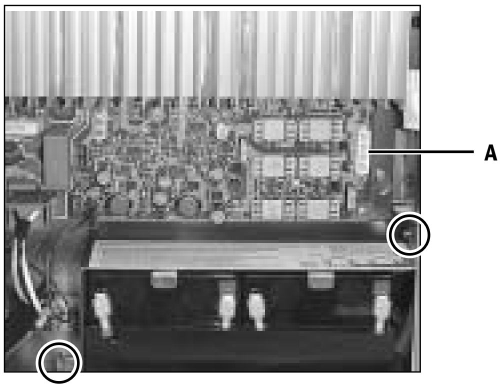
2. Loosen the six screws (**circled**) that hold the Anesthesia Control board to the enclosure.
3. Lift the Anesthesia Control board slightly to release it from the keyhole slots.
4. To replace the Anesthesia Control board, reassemble in reverse order.
5. Load Software.
6. Check/Reconfigure the Machine Configurations (Install/Setups).
7. Perform User Calibrations (Section 4a.5.1 or Section 4b.5.2).
8. Zero Gas Transducers (Section 4a.5.7 or Section 4b.5.8).
9. Perform all Ventilator Calibrations (Section 5.4).

9.8.4 Backup batteries

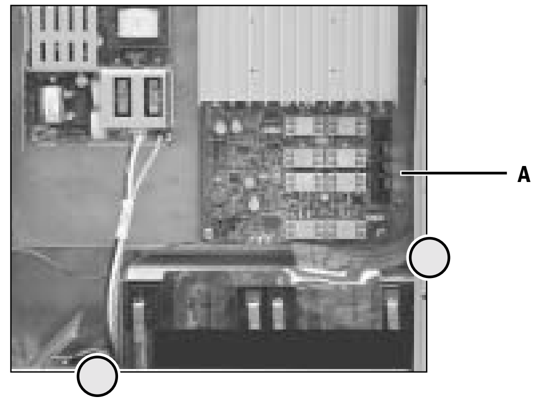
To remove the batteries

1. Disconnect the battery cable from the Power Controller board (**A**).

(original)



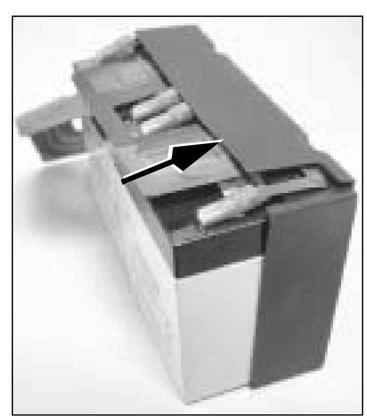
(PCB/U-FramePS)



2. Loosen the two nuts (**circled**) that hold the battery restrainer to the enclosure.
3. To remove the restrainer, slide it forward (toward you) and then to the left.
4. Remove the battery pack from the machine.
5. Set the batteries upright (terminals up) and slide them out of the tray.
6. Remove the harness from the batteries.

To replace the batteries

1. Gently bend the tabs up, just enough for clearance to install the harness.
2. Place the batteries side by side and install the harness.
3. Slide the tray over the side of the batteries.
4. Guide the harness into the slot on the edge of the tray.
5. Position the battery tray assembly upright.
6. To replace the battery tray assembly, reassemble in reverse order.
7. Allow the batteries to charge.
8. Recycle old batteries in same packaging according to local requirements.



9.8.5 Fan

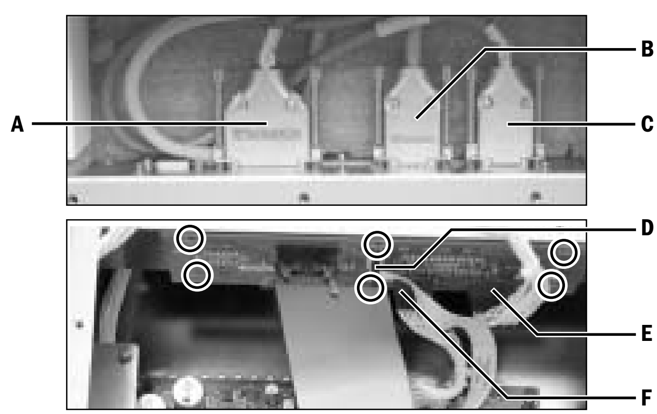
The fan is mounted to the side of the enclosure and draws air into the enclosure through the filter on the AC Inlet assembly. For easier access, temporarily remove the backup batteries (Section 9.8.4).

1. Disconnect the fan harness from the Power Controller board (**Fan1**).
2. Remove the two screws that hold the fan to the enclosure.
3. To replace the fan, reassemble in reverse order.
   - Ensure that the fan is oriented with the flow direction arrow pointing toward the inside of the enclosure.

9.8.6 Display Connector board

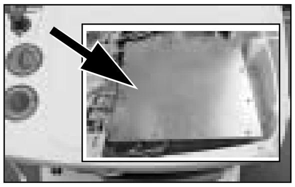
To replace the Display Connector board, first remove the Power Controller board (Section 9.8.1). Then, follow the procedure below:

1. Disconnect the cables from the top of the Display Connector board:
   - Airway Module (MGAS) Power Supply board (**A**).
   - System Signal Interface to Display Unit (**B**).
   - System Power Interface to Display Unit (**C**).
2. Disconnect the cables from the top of the Display Connector board:
   - Harness from Power Controller board (**D**).
   - Harness from Anesthesia Control board (MGAS power) connector (**E**).
   - Ribbon cable from Anesthesia Control board (signal) connector (**F**).



3. Loosen the six screws (**circled**) that hold the Display Connector board to the enclosure.
4. Slide the Display Connector board slightly rearward to release it from the keyhole slots.
5. To replace the Anesthesia Control board, reassemble in reverse order.

9.9 Servicing the pan electrical enclosure components



The pan electrical enclosure includes the following components (Section 10.10):

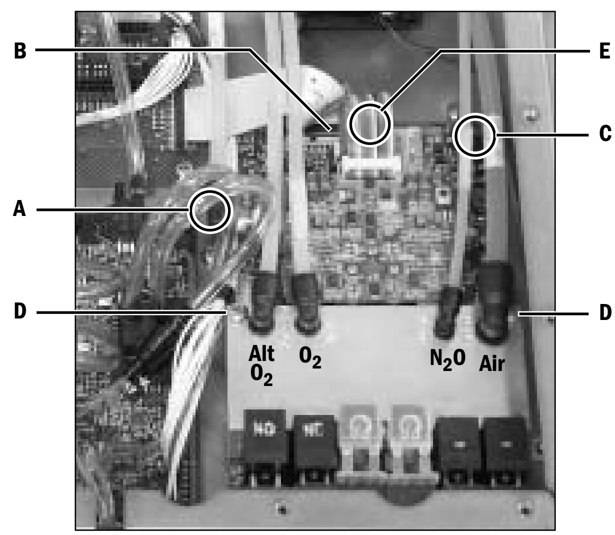
- the Electronic Gas Mixer assembly
- the Ventilator Interface board
- the Filter board
- the Pan Connector board
- the pan enclosure fan

To replace these components, remove the tabletop (Section 9.4) and the pan enclosure cover.

9.9.1 Electronic Gas Mixer assembly

The following procedure describes how to replace the Electronic Gas Mixer assembly.

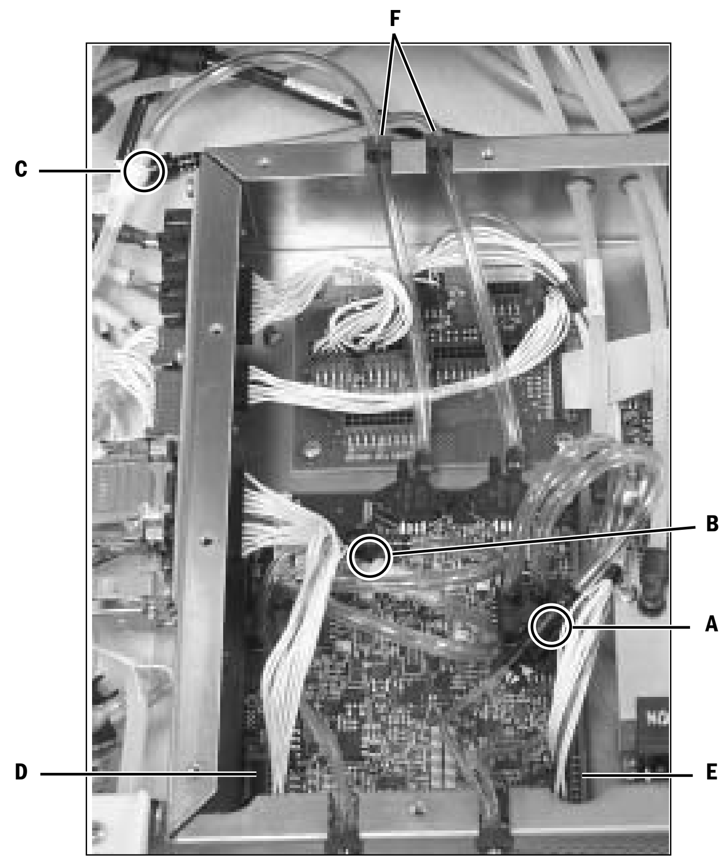
1. Bleed all gas pressure from the machine (Section 9.2).
2. Ensure that all cylinder and pipeline pressures read zero before proceeding.
3. Disconnect the inlet tubing elbow fittings from the manifold. If the machine does not include N_2O, transfer the plug from the N_2O inlet to the replacement assembly.
4. Disconnect outlet tubing from the elbow fitting (**A**).



5. Disconnect the ribbon cable from the Pan Connector board (**B**).
6. Disconnect the fan harness (**C**).
7. Remove the two screws (**D**) that hold the manifold to the enclosure.
8. Remove the mounting screw (**E**) at the front edge of the main circuit board.
9. To replace the Electronic Gas Mixer assembly, reassemble in reverse order.
10. Load Software.
11. Zero Mixer Pressure Transducers (Section 4a.5.9 or Section 4b.5.10).

9.9.2 Ventilator Interface board

1. Disconnect the white and black inline tubing fittings from the Inspiratory pressure transducer (**A**).
2. Disconnect the blue and yellow inline tubing fittings from the Expiratory pressure transducer (**B**).
3. Disconnect the white inline tube fitting from the Manifold pressure transducer and the black inline tube fitting from the Airway pressure transducer (**C**).



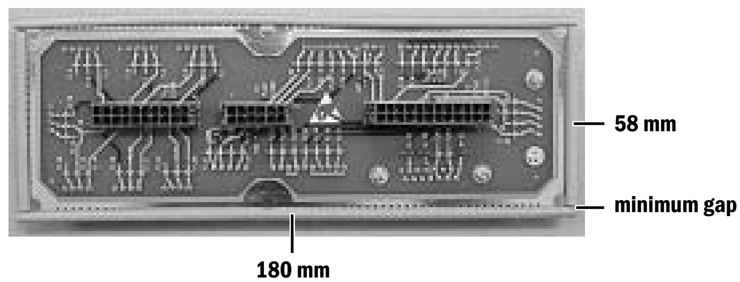
4. Disconnect the harness from the Filter board (**D**).
5. Disconnect the harness from the Pan Connector board (**E**).
6. Remove the four mounting screws, one at each corner, that hold the board to the enclosure.
7. To replace the Ventilator Interface board, reassemble in reverse order.
   - Ensure that the tubing fittings are connected to like color fittings and that the tubing will not kink when the cover is replaced.
   - Transfer the grommets to the Manifold and Airway pressure tubing (**F**).
8. Load Software.
9. Perform User Calibrations (Section 4a.5.1 or Section 4b.5.2).
10. Perform all Ventilator Calibrations (Section 5.4).

9.9.3 Filter board

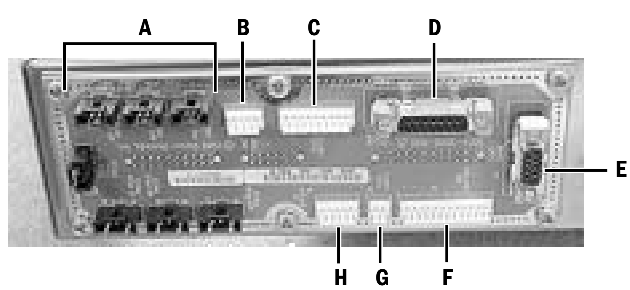
Before replacing the Filter board, you must apply an EMI gasket around the edges of the board that face the enclosure. Refer to section Section 10.10 for required parts.

You can replace the Filter board without removing the enclosure cover, if you do not have to remove cover for other reasons.

1. Cut the gasket pieces to length and apply them to the board as shown:
   - Do not block the mounting holes.
   - Keep the corner gaps to a minimum.



2. Disconnect all cables and harnesses from the front-side of the board:
   - Transducer cables from the pipeline and cylinder gas supplies (**A**)
   - Harness from system switch (**B**)
   - Harness from SCGO/ACGO (**C**)
   - Cable from flow sensors (**D**)
   - Cable from Vent Engine board (**E**)
   - Harness from ABS switches (**F**)
   - Harness from task lights (**G**)
   - Harness from Alt O_2 (**H**)

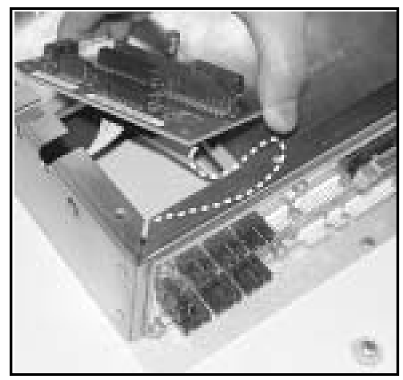


3. Remove the six screws that hold the Filter board to the enclosure. (If the enclosure cover is removed, disconnect the three harnesses from the back-side of the board before removing the mounting screws.)
4. If the cover is in place, pull the Filter board away from the enclosure and disconnect the three harnesses from the back-side of the board.
5. To replace the Filter board, reassemble in reverse order.

9.9.4 Pan Connector board

The Pan Connector board is a wiring interface between the lower electrical enclosure components and the pan electrical enclosure components (refer to Figure 11-11).

1. Disconnect the wiring from the top-side of the Pan Connector board:
    - Two harness connectors coming from the Filter board.
    - One harness connector coming from the Ventilator Interface board.
    - One ribbon cable connector coming from the Electronic Gas Mixer.
2. Remove the four screws that hold the Pan Connector board to the enclosure.
3. Lift the Pan Connector board away from the enclosure and disconnect the large ribbon cable and the harness from the under-side of the board.
4. To replace the Pan Connector board, reconnect the large ribbon cable and the harness to the under-side of the board.
5. Lower the Pan Connector board over the gasketed opening in the pan enclosure.
    - Keep the extra length of ribbon cable in the pan area.
    - Fold the ribbon cable under the enclosure toward the front of the machine.
6. Secure the board to the enclosure.
7. Reconnect the harnesses and ribbon cable to the top-side of the board.
8. Reassemble in reverse order.

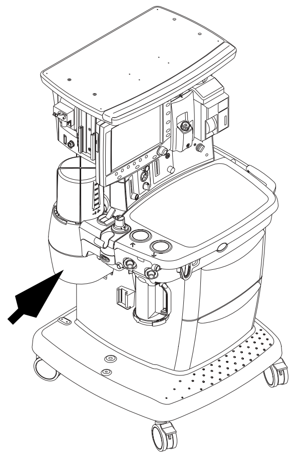


9.9.5 Pan enclosure fan

The fan is mounted to the back-side of the enclosure and draws air into the enclosure.

1. Disconnect the fan harness from the Mixer board (**A**).
2. Remove the two screws that hold the fan to the enclosure.
3. To replace the fan, reassemble in reverse order.
    - Ensure that the fan is oriented with the flow direction arrow pointing toward the inside of the enclosure.

9.10 Servicing the Vent Engine

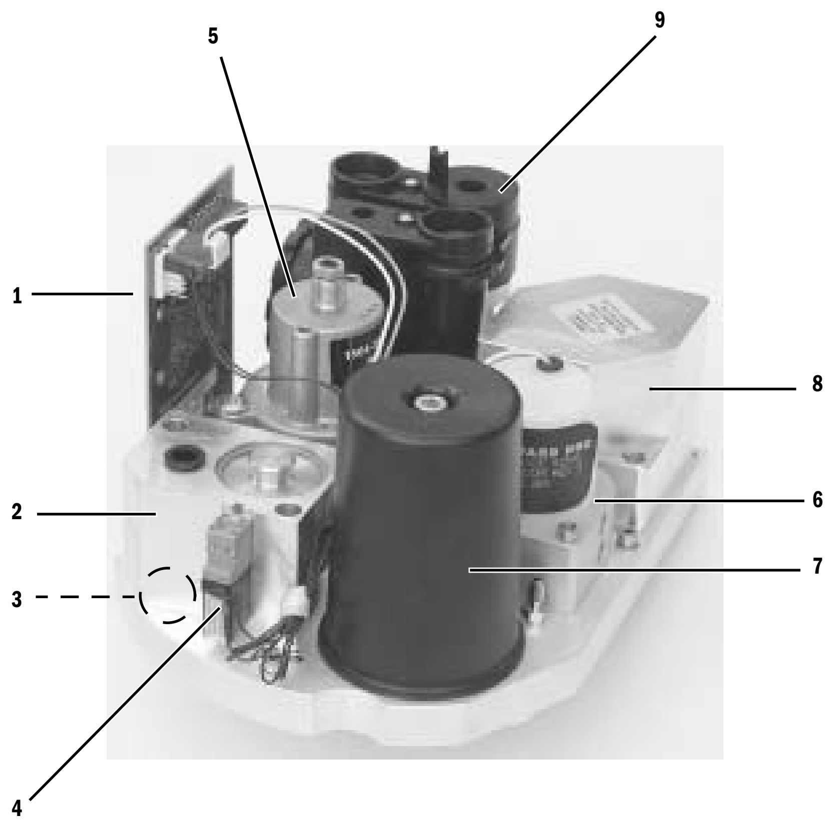


The Vent Engine is found in a housing located below the breathing system bellows assembly.

The Vent Engine includes the following subassemblies.

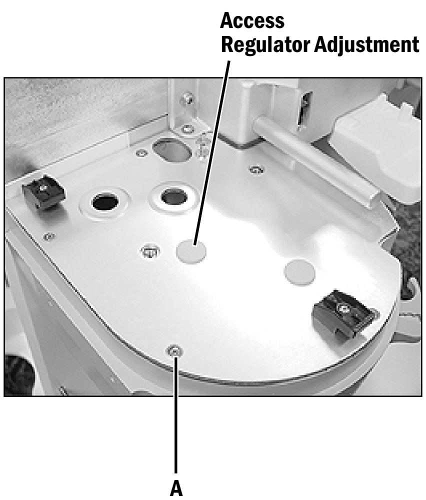
- Vent Engine Connector board (**1**)
- Gas Inlet Valve Assembly (**2**)
- Inlet Filter (**3**) - located under the gas inlet valve
- Inlet Valve Solenoid (**4**)
- Drive Gas Regulator (**5**)
- Flow Control Valve (**6**)
- Reservoir (**7**)
- Drive Gas Check Valve (**8**)
- Interface Manifold (**9**)

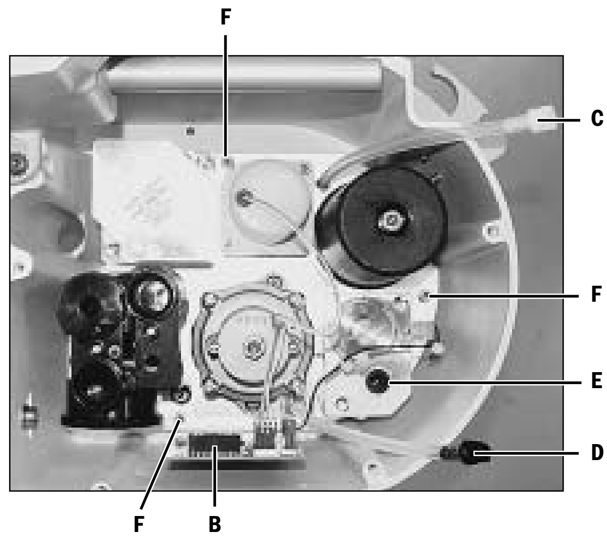
To replace any of the Vent Engine components, you must first remove the Vent Engine from the housing (refer to Section 9.10.1).



9.10.1 To remove the Vent Engine

1. Disconnect pipeline supplies; close cylinder valves; bleed off pressure.
2. Remove the ABS breathing system.
3. Remove the Exhalation valve.
4. Remove the scavenging downtube.
5. Loosen the five captive screws (**A**) that hold the Vent Engine cover to the housing. Raise the cover to access the Vent Engine.

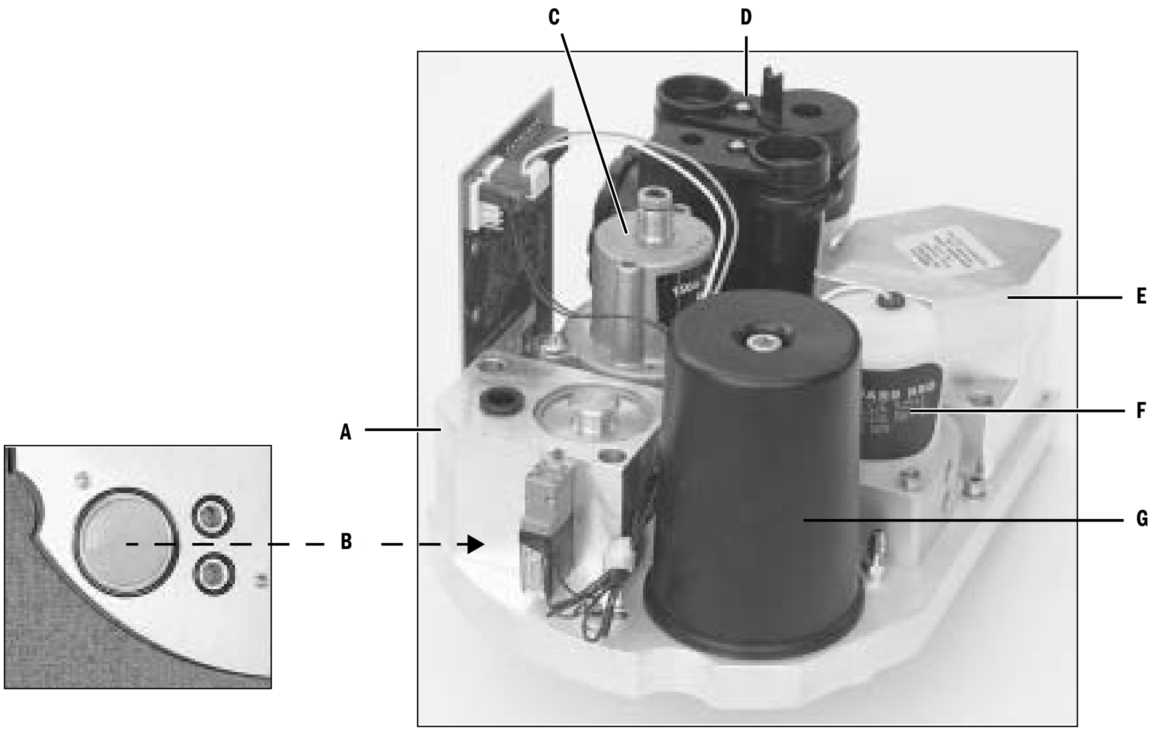




6. Disconnect the Vent Engine harness (**B**).
7. Disconnect the white tube-coupler (**C**) — inline with tube to manifold pressure transducer on the Ventilator Interface Board.
8. If present, disconnect the black tube-coupler (**D**), inline with tube to AGSS flow indicator.
9. Disconnect the drive gas hose (**E**).
10. Loosen the three captive screws (**F**) that hold the engine manifold to the housing.
11. Lift the Vent Engine out of the housing.
12. To replace the Vent Engine, reassemble in reverse order.

9.10.2 Replacing Vent Engine components

Refer to Section 6 for Vent Engine components that are to be serviced under regular maintenance. Most of the components on the Vent Engine can be replaced by removing the mounting screws and reusing them to secure the replacement part.



Gas Inlet Valve (A)

Inspect the two o-rings that seal it to the manifold. Replace as necessary.
To replace GIV shuttle valve components, refer to Section 9.10.3.

Inlet Filter (B)

Install the filter with the smooth side facing up.
Inspect the o-ring. Replace as necessary.

Regulator (C)

Inspect the two o-rings that seal it to the manifold. Replace as necessary.
Perform the Drive Gas Regulator calibration in Section 5.3.

Interface Manifold (D)

Inspect the two o-rings that seal it to the manifold. Replace as necessary.
Lubricate o-rings sparingly with Krytox.

Drive Gas Check Valve (E)

Inspect the o-ring that seals it to the manifold. Replace as necessary.
Clean the seat on the manifold and the seal on Drive Gas Check Valve with isopropyl alcohol.

Inspiratory Flow Valve (F)

Note orientation of the flow valve. Inspect the two o-rings that seal it to the manifold. Replace as necessary.
Perform the Inspiratory Flow Valve calibration in Section 5.4.3.

Reservoir (G)

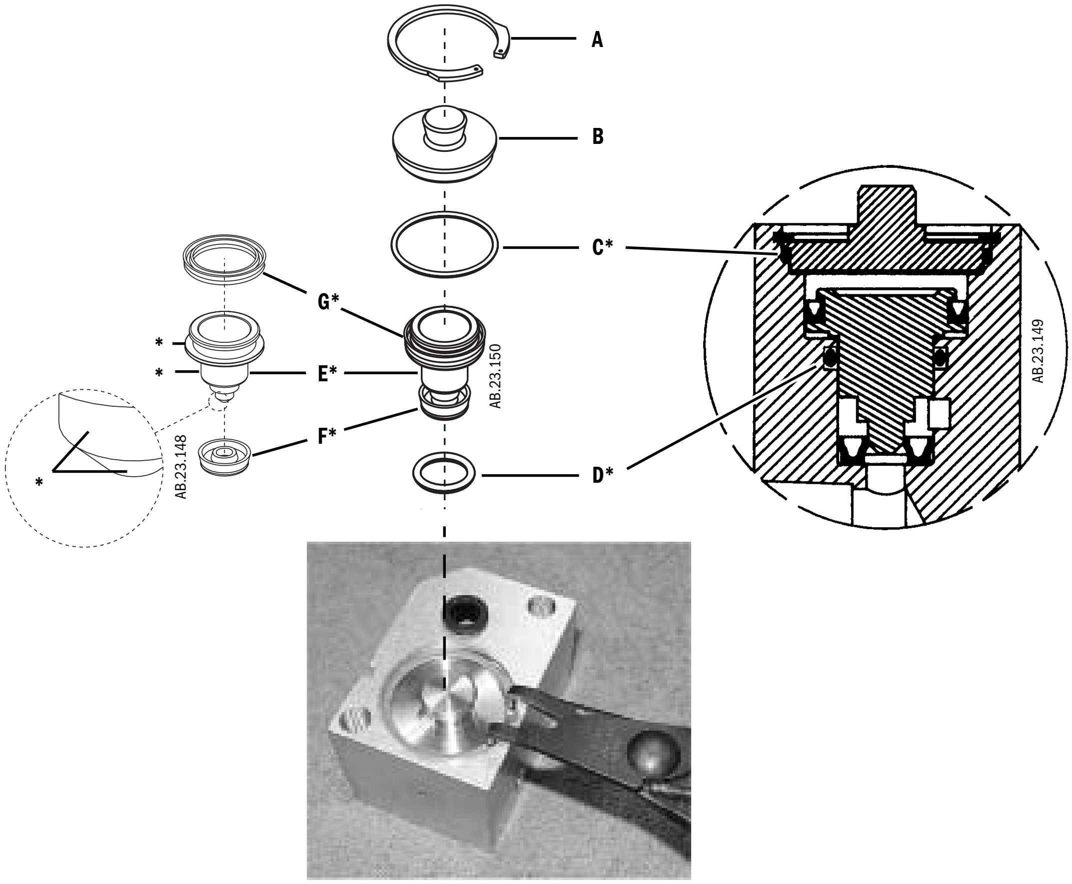
Inspect the two o-rings: reservoir to manifold, reservoir to screw head.
Replace as necessary.

Inlet Valve Solenoid (H)

Inspect seal between solenoid and GIV body.
Replace as necessary (included with solenoid).

9.10.3 Replacing GIV components

Lubricate items marked with an asterisk (*) sparingly with Krytox.



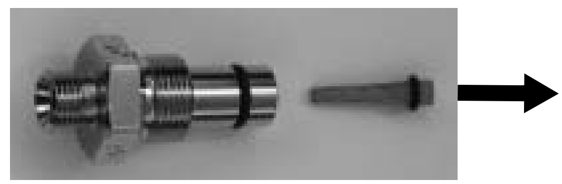
1. Remove the retaining ring (**A**) and the GIV cap (**B**).
2. Use pneumatic pressure to remove the shuttle. Cover the shuttle with a cloth and briefly apply pressure (connect the drive gas hose or use pipeline pressure) through the drive gas inlet.
3. Remove the upper o-ring (**C**) and the lower o-rings (**D**).
4. Install the lower o-ring (**D***).
5. Lubricate the shuttle (**E**) at the three areas (*) shown: the circumference of the shuttle where the upper and lower u-cup seals are placed and the body part of the shuttle that slides along the lower o-ring.
6. Install the lower u-cup seal (**F***) and the upper u-cup seal (**G***) on the shuttle.
7. Press the shuttle assembly into the GIV manifold.
8. Install the upper o-ring (**C***).
9. Install the cap (**B**) and the retaining ring (**A**).
10. Reassemble in reverse order.

9.11 Servicing the pipeline inlet manifold components

The pipeline inlet filter and the inlet check valve can be replaced without removing the pipeline manifold from the machine. To replace the pressure transducer, you have to remove the manifold.

9.11.1 Replace pipeline inlet filter

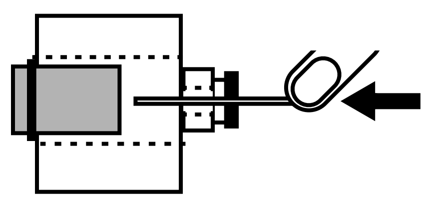
1. Remove the pipeline inlet fitting.
2. Pull the pipeline inlet filter out of the fitting. The o-ring should come out with the filter.



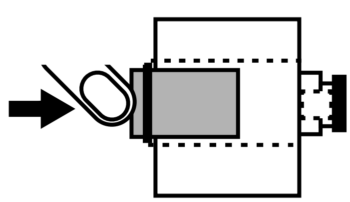
3. Install the new pipeline inlet filter in the pipeline inlet fitting. The new filter comes with an o-ring.

9.11.2 Replace pipeline inlet check valve

1. Remove the rear panel (Section 9.3).
2. Remove the pipeline inlet fitting.
3. The Air and O_2 pipeline manifolds include a drive gas connection at the back of the manifold. Remove the drive gas tube or plug to access the check valve.
4. From the back of the pipeline manifold, use a thin tool to push out the check valve. (For an N_2O manifold, you will have to carefully apply pressure at the outlet of the manifold — with a syringe for example — to gently force the check valve out of the manifold).



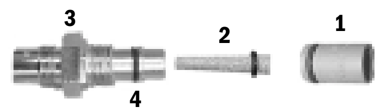
5. Push the new check valve into the opening, using the same thin tool. The new check valve includes an o-ring — orient it toward the pipeline inlet. **Note:** Make sure to push the new check valve all the way back into the opening until it bottoms out on the shoulder.

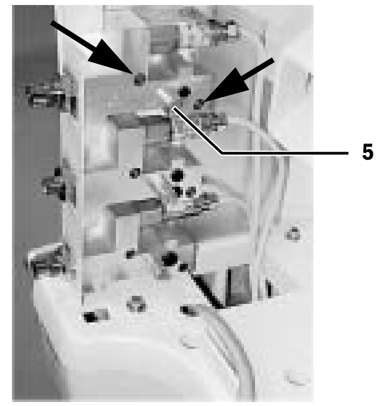


6. Install the pipeline inlet fitting.

9.11.3 Replace the inlet manifold

1. Remove the rear panel (Section 9.3).
2. Disconnect the tubing from the manifold outlet(s).
3. Remove the two screw that hold the manifold to the side extrution.





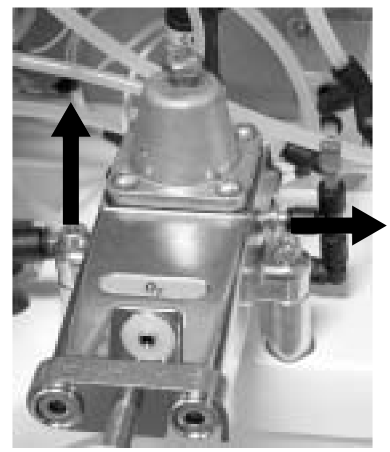
4. Transfer the following item to the replacement manifold or install new as required.
   - pipeline check valve (1)
   - inlet filter (2)
   - inlet fitting (3) and o-ring (4)
   - relief valve (5)
5. Transfer the pressure transducer to the new supply (Section 9.13).
   - Ensure the o-ring is in place.
   - Install the transducer.
6. To reassemble, perform the previous steps in reverse order.
7. Perform the checkout procedure (Section 3).

9.12 Service the cylinder supply modules

⚠ **WARNING** Be careful not to expose internal components to grease or oil (except Krytox or equivalent).

9.12.1 Replace primary regulator module (complete replacement)

1. Bleed all gas pressure from the machine (Section 9.2).
2. Ensure that all cylinder and pipeline pressures are at zero before proceeding.
3. Remove the rear panel (Section 9.3).
4. Disconnect the output tube fitting.
5. Remove the three mounting screws and lockwashers.
6. Remove the elbow fitting from the replacement gas supply.
7. Transfer the pressure transducer to the new supply (Section 9.13).
   - Remove any teflon tape remnants from the transducer mounting threads (transducer and module).
   - Apply 1-1/4 turns of new teflon tape around the treads. Verify that the first few threads are free of tape.
   - Install the transducer.



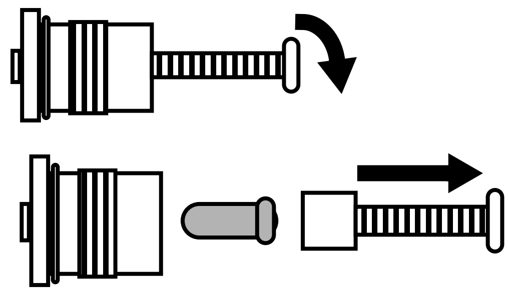
8. To reassemble, perform the previous steps in reverse order.
   - Pull on the cylinder output fitting to ensure it is locked in place.
9. Check the output of the regulator BEFORE you install the rear panel. Adjust if necessary (Section 5.1).
10. Perform the checkout procedure (Section 3).

9.12.2 Replace cylinder inlet filter

1. Open the cylinder yokes.
2. Remove the inlet adapter from the cylinder yoke, using a 4 mm hex wrench.

   Note: A brass retaining ring keeps the filter inside the inlet adapter.
3. Thread a 6-mm screw (two turns only) into the brass retaining ring and pull it out.

⚠ **CAUTION** Be careful not to crush the filter. Do not thread in the screw more than two full turns.



4. Remove the filter.
5. Install the new filter and brass retaining ring.
6. Install the inlet adapter in the cylinder yoke.
7. Perform the checkout procedure (Section 3).

9.12.3 Replace cylinder check valve

The cylinder check valve is not a replaceable item. If the check valve is defective, you must replace the complete cylinder supply module.

9.13 Replace gas-supply pressure transducers

The gas-supply pressure transducer includes an integral cable that connects to the Filter board on the pan enclosure. The transducer itself is mounted directly to the supply module. To replace a pressure transducer (pipeline or cylinder) you have to remove the module from the machine.

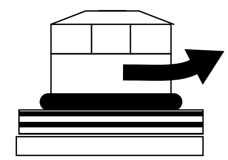
1. To access the Filter board, remove the tabletop (Section 9.4).
2. Disconnect the transducer cable from the Filter board.
3. Remove the supply module to access transducer.
    - For cylinder supplies, refer to Section 9.12.
    - For pipeline supplies, refer to Section 9.11.
4. Remove the transducer from the module.
5. Install the new transducer.
    - For pipeline transducers:
        - Be sure that an o-ring is in place.
    - For cylinder transducers:
        - Remove any teflon tape remnants from the module.
        - Apply 1-1/4 turns of teflon tape around the treads of the transducer. Verify that the first few threads are free of tape.
        - Install the transducer.

6. To reassemble, perform the previous steps in reverse order.
7. Perform the checkout procedure (Section 3).

9.14 Service vaporizer manifold parts

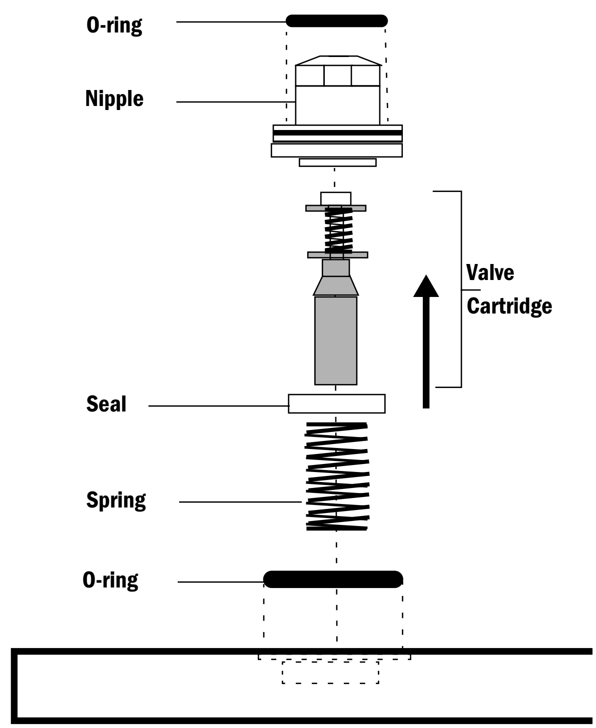
9.14.1 Repair manifold port valve

1. Set the system switch to Standby.
2. Remove the vaporizers from the vaporizer manifold.
3. Using a 14-mm wrench, carefully remove the valve nipple (threaded).



4. Disassemble as necessary to replace parts. The following illustration shows the parts.

Note: The port valve replacement kit includes the valve cartridge assembly and the seal. The kit does not include o-rings.



5. When installing a new valve cartridge assembly into the vaporizer manifold, put a light coat of Krytox on the bottom portion of the cartridge. The bottom portion of the cartridge is defined as the brass surface that is inserted in the lower spring. **Note:** Do not apply Krytox to the valve seal.
6. Verify that the parts are free of dust and dirt.
7. To reassemble, perform the previous steps in reverse order.
8. Complete the port valve checkout procedure described below (Section 9.14.2).

9.14.2 Checkout procedure for manifold port valve

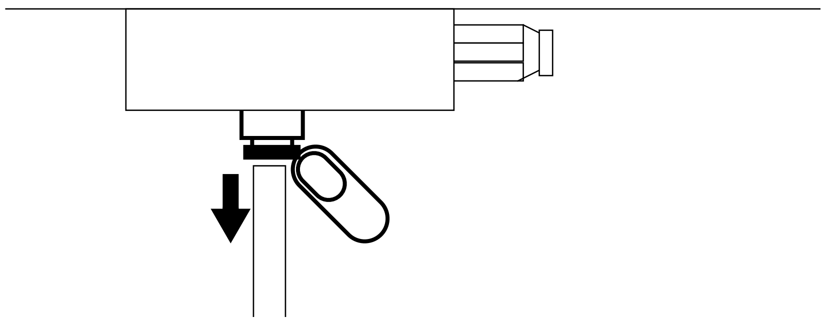
Use the Vaporizer Manifold Valve Test Tool to perform the checkout procedure for the manifold port valve. This tool and test procedure are intended for use only when the valve cartridge assembly is replaced.

Note This replacement and test procedure is a service action and is not part of the maintenance program.

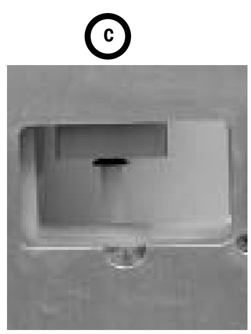
1. Set the system switch to Standby.
2. After replacing the valve cartridge assembly, remove the vaporizer port o-ring.
3. Attach the valve tester to the top of the valve by sliding the bottom of the tester onto the o-ring groove.
4. Tighten the tester screw down onto the valve until the screw bottoms out on the top of the valve. The tester o-ring should create a seal with the top of the valve.
5. With the Inspiratory Flow Sensor open to atmosphere (do no plug the right-hand port), verify that the system passes the Low P leak check in the System Checkout (Section 3.4.1).
6. Remove the valve tester.
7. Reassemble the vaporizer port o-ring.
8. Conduct a negative low-pressure leak test on the system.
9. Perform system “All checks” (Section 3.4).

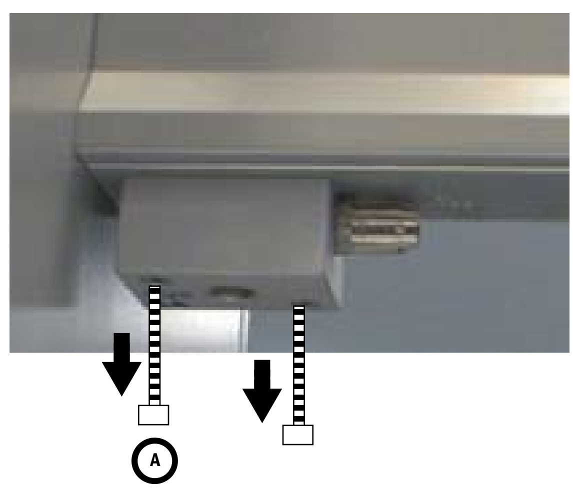
9.14.3 Replace vaporizer manifold check valve

1. Set the system switch to Standby.
2. Remove the vaporizers from the vaporizer manifold.
3. Remove the upper rear panel.
4. Disconnect the tubing from the valve block.



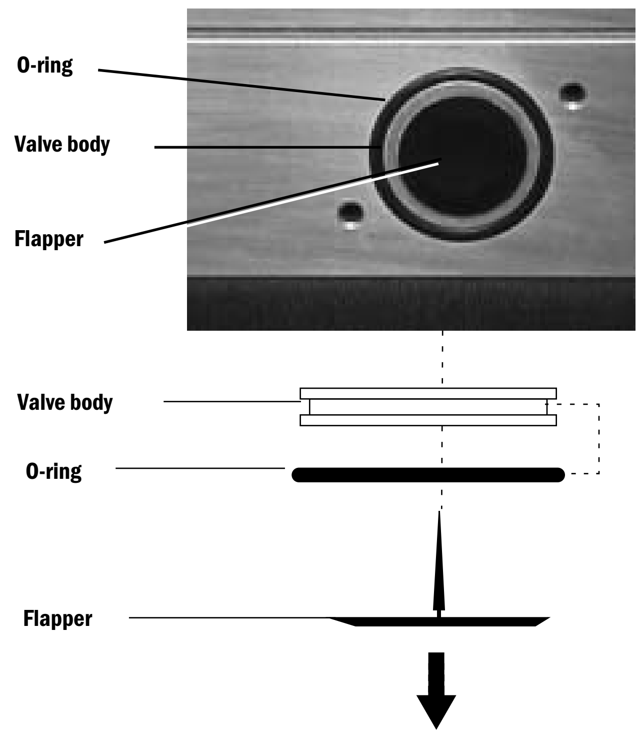
5. Remove the valve block.
   - To access the left-hand mounting screw (**A**), remove the right (viewed from front) side panel (**B**).
   - The right-side extrusion include an access hole (**C**) for removing the left-hand mounting screw.
   - **Note:** For early production machines that do not have an access hole in the extrusion, you must remove the vaporizer manifold to remove the valve block.





Note The valve body, o-ring, and flapper do not come out with the block. They stay intact at the bottom of the vaporizer manifold.

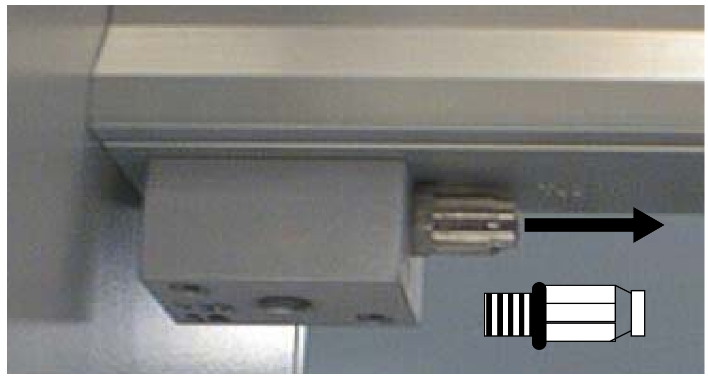
6. Pull the flapper out of the valve body.



7. Using a hex wrench, put the wrench through one of the holes of the valve body and pull down to remove the valve body and o-ring.
8. Verify that parts are free of dust and dirt.
9. Replace the flapper by inserting the flapper stem and gently pulling the stem until the flapper secures to the valve body.
10. Lightly lubricate the o-ring with Krytox.
11. Place the lubricated o-ring on the valve body port at the bottom of the manifold.
12. Gently install the valve body in the manifold:
    - Check that the o-ring makes a good seal between the manifold and the valve body.
    - Check that the flapper valve makes solid contact with the valve body.
13. Install the valve block.
14. Reconnect the tubing to the valve block. Pull on the tube to ensure that it is locked in the fitting.
15. Install the vaporizer front panel.
16. Perform the checkout procedure (Section 3).

9.14.4 Replace vaporizer pressure relief valve

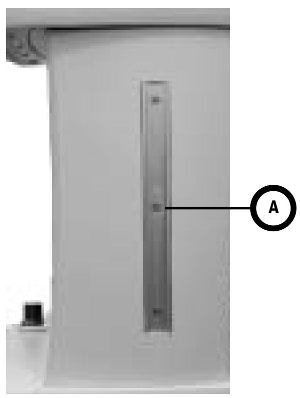
1. Set the system switch to Standby.
2. Remove the vaporizers from the vaporizer manifold.
3. Remove the upper rear panel (Section 9.3).
4. Using a 13mm open ended wrench, remove the vaporizer pressure relief valve by turning counterclockwise.

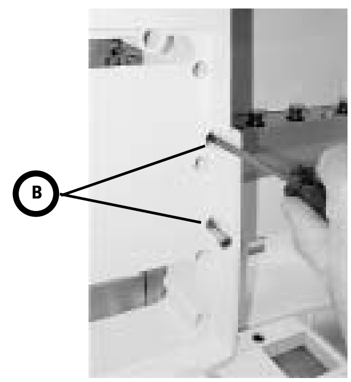


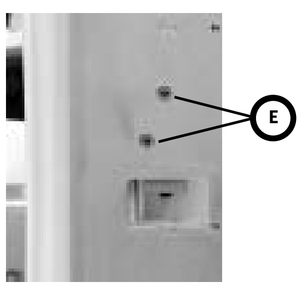
5. Verify that the parts are free of dust and dirt.
6. Install a new vaporizer pressure relief valve.
7. To reassemble, perform the previous steps in reverse order.
8. Perform the checkout procedure (Section 3).

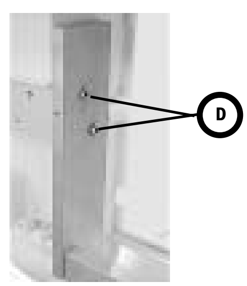
9.14.5 Replace vaporizer manifold

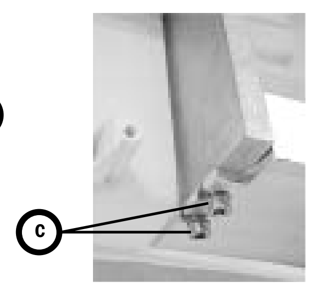
1. Remove the upper rear panel (Section 9.3).
2. Remove the Display Unit.
3. Remove the right side panel (**A**).
4. From the front of the machine, remove the two screws (**B**) that hold the front bezel to the vertical support.
5. From the back of the machine, remove the two screws (**C**) that hold the vaporizer manifold vertical support to the horizontal bracket.
6. From the back of the machine, remove the two screws (**D**) that hold the vertical support to the vaporizer manifold.
7. Remove the vertical support from the machine.
8. While holding the vaporizer manifold, remove the two screws (**E**) at the right-hand extrusion to release the manifold.









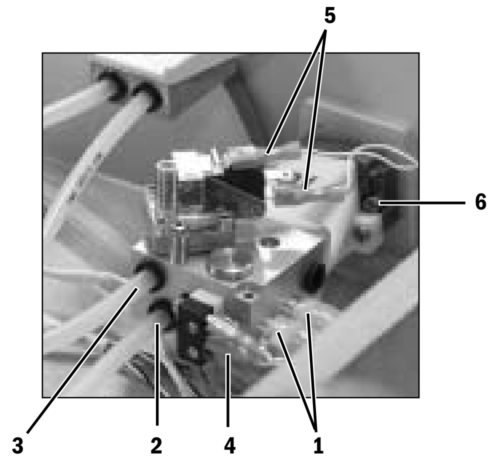


9. Install the new vaporizer manifold in reverse order. Do not fully tighten the screws until they are all in place.
   - Attach the new manifold to the right-hand extrusion (**E**).
   - Attach the vertical support to the vaporizer manifold (**D**).
   - Attach the bottom of the vertical support to the horizontal bracket (**C**).
   - Attach the vertical support to the front bezel (**B**).
10. Tighten the mounting screws in the following order: **E**, **D**, **C**, **B**.
11. Reassemble the machine.
12. Perform the checkout procedure (Section 3).

4.15 Replace ACGO selector switch

Removal

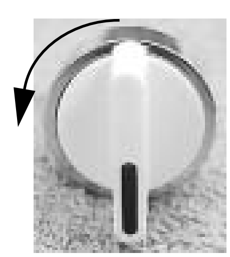
1. Remove the tabletop (Section 9.4).
2. Clip the tie wraps (**1**) from the outlet barb fittings at the side of the switch.



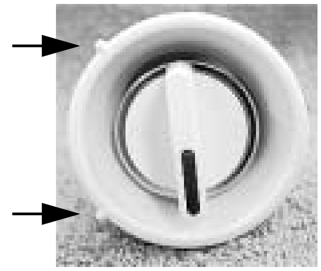
3. Disconnect the fresh gas (**2**) and flush (**3**) tubes at the back of the switch.
4. Disconnect the wires from the ACGO mode microswitch (**4**) at the back of the selector switch.
5. Disconnect the wires from the flush pressure switch (**5**) on top of the selector switch.
6. Set the ACGO selector switch to ABS.
7. Back out the selector switch mounting screws (**6**) until the tips are flush with the face of the mounting casting.
8. While pushing the selector knob toward the machine and holding it steady, push the valve body toward the knob and rotate it counterclockwise to separate the valve body from the knob assembly.
9. Remove the knob assembly and protective shroud from the machine.
10. Remove the valve from the silicone output tubes.

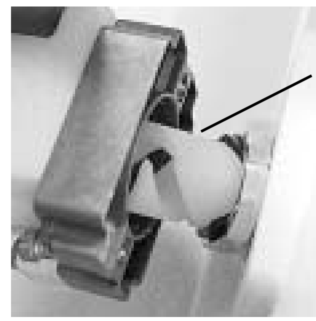
Replacement

1. Remove the knob assembly from the valve body.
2. Back out the selector switch mounting screws until the tips are flush with the face of the mounting casting.
3. Guide the outlet fittings of the valve body into their respective silicone tubes.
4. Hold the selector knob with the indicator mark facing down. Turn the chrome collar to its maximum counterclockwise position (as viewed from the front).



5. Place the shroud over the knob and guide the assembly into the pan opening.
6. Ensure that the indicators on the shroud align with label on the pan and the alignment tab mates with the alignment hole in the pan.



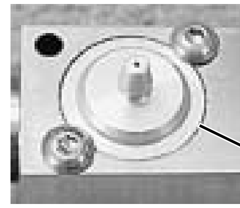


7. While holding the knob assembly steady against the pan, place the valve assembly over the knob actuator. Using moderate force press the two assemblies together. The knob should rotate to the ACGO position.
8. While continuing to force the assemblies together, rotate the knob assembly to the ABS position. The assemblies should snap into place.
9. Verify proper alignment of the knob with the setting indicators. Tighten the mounting screws evenly to secure the switch assembly to the pan.
10. Secure the outlet tubing with tie wraps.
11. Connect the fresh gas and flush gas tubing. Pull on the tubing to ensure that it is locked in the fitting.
12. Reconnect the wires to the ACGO mode microswitch at the back of the valve (top two terminals).
13. Reconnect the wires to the flush pressure switch at the top of the valve (upper and lower terminals).
14. Replace the tabletop.

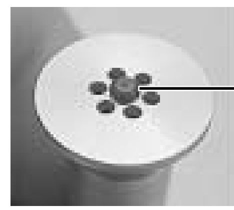
Test procedure

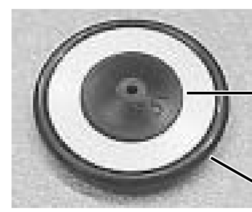
1. Confirm that flush flow and 5 L/min fresh gas flow are diverted to the ACGO port and the ABS in the respective knob positions.
2. Confirm that the ventilator display indicates ACGO mode when the valve is set in the ACGO position.
3. Test the function of the flush pressure switch:
   - DU – "Vent Diagnostics - Status" – Section 8a.3.1)
   - HPDU (4.X or 5.X) – "Special Functions - Vent Diagnostics - Vent Status" – Section 8b.4.1)
   - HPDU (5.X) – PC Service App "Vent Subsystem - Vent Status" – Section 12.9.1)
4. Perform the low-pressure leak test (Section 3.4.1).
5. Perform the checkout procedure (Section 3).

9.16 Clean or replace ACGO port flapper valve



1. Remove the tabletop (Section 9.4).
2. Remove the ACGO cap mounting screws.
3. Remove the cap.
4. Examine the flapper and disk for obstructions or debris. Clean with isopropyl alcohol if necessary; retest.
5. If leak persists, replace the flapper.

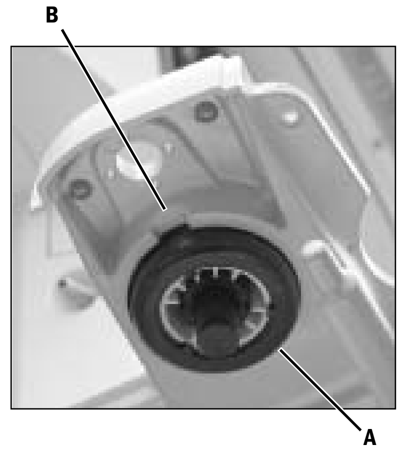




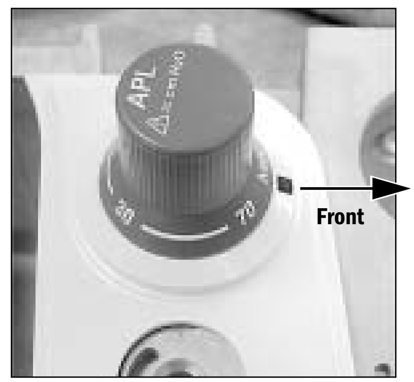
   - Remove the flapper from the check valve disk.
   - Clean the new flapper with isopropyl alcohol.
   - Apply a drop of isopropyl alcohol to the center hub of the new flapper.
   - Before the alcohol evaporates, align the center hub of the new flapper with the center hole of the check valve disc.
   - While pressing the flapper against the disc, use your fingernail to help pull the hub through the disc from the other side.
6. Lubricate the o-ring sparingly with Krytox (do not get Krytox on the flapper).
7. Insert the flapper assembly into the ACGO outlet with the flapper up.
8. Replace the cap.

9.17 Replace the APL valve

1. Remove the ABS breathing system.
2. The APL valve is held in place with a spring and a retainer (**A**) that snaps into a recess in the lower body of the APL valve. To release the retainer, place an appropriately sized straight blade screwdriver into the housing cutout (**B**). Twist the screwdriver to release the retainer.



3. Place the new APL valve into position with the setting indicator facing to the front of the machine.
4. Place the spring into the retainer.
5. While holding the APL valve tight to the housing, snap the spring and retainer onto the valve body from below.
6. Reinstall the ABS breathing system.
7. Perform the checkout procedure (Section 3).



9.18 Replace the bag support arm

1. Remove the ABS breathing system from the machine.

Note: To help prevent the bag arm mounting from loosening, current production machines use socket head screws and flat washers to secure the bag arm to the casting instead of Posidriv screws and lockwashers. Refer to the parts section for stock numbers.

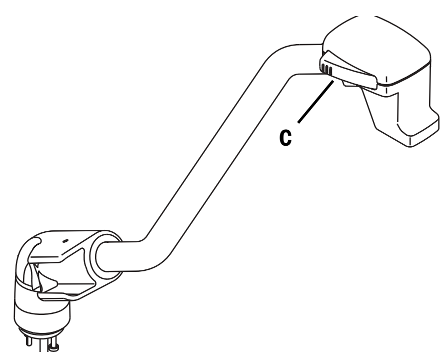
2. From the underside of the casting, remove the hardware (**A**) that holds the arm in place.
   - If either of the pins (see below) remain in the casting, remove them from the casting.

3. Install the new bag support arm assembly.
   - Position the bag arm over mounting pattern of 4 small holes in the support casting. The arm should extend towards the front of the machine. Align the two pins (**B**) extending from the base of the bag arm assembly, with two of the small holes in the casting that are in line with the APL valve.

   - Lower the bag arm, pushing the two pins into the holes.
   - From the underside of the casting, secure the bag arm with two M3x20 socket head screws and flat washers.
4. Test the force required to swing the bag arm from side to side and adjust if necessary.

Note: The adjustment nut is initially set so that 5-mm of exposed thread extends from the adjusting nut. With use, the force required to move the arm increases and may require readjustment.

   The force is adjusted by turning the lock nut (8-mm socket) which is accessible from underneath the support casting. Turn clockwise to increase the force and counterclockwise to reduce the force.



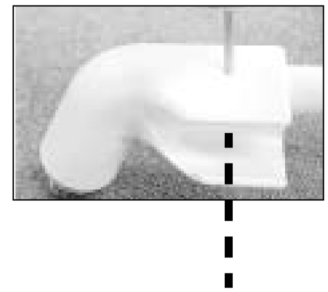
   - Swing the bag arm sideways through the 90 degree arc permitted by its internal stop.
   - Adjust to just enough friction to prevent the bag arm from swinging sideways as the bag height is being changed. The bag arm height is changed by squeezing the lock release lever (**C**) at the free end of the bag arm and rotating it to the desired position.
5. Replace the ABS breathing system.

9.18.1 Servicing the bag support arm

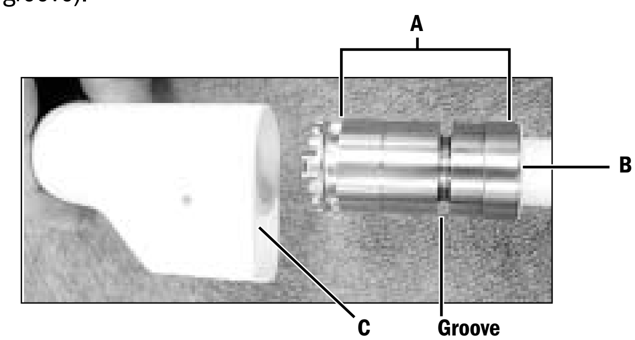
Service parts for the bag support arm include the upper and lower assemblies.

To replace either assembly:

1. Remove the bag support arm from the machine (Section 9.18).
2. To separate the upper assembly from the lower assembly, use a small (2.5-mm) pin punch from the bottom to drive the dowel pin up and out.



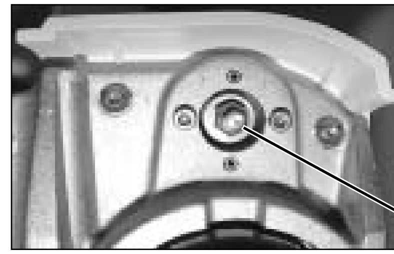
3. To assemble the bag arm, apply a light coat of Krytox to the area of the upper arm (**A**) that extends into the lower arm (including the dowel pin groove).



4. Insert the upper assembly into the lower assembly. Align the surface (**B**) of the upper assembly with the surface (**C**) of the lower assembly.
5. Insert the dowel pin into the hole (from the top side as shown). Drive the dowel pin into the bag arm until it is flush with the top surface.

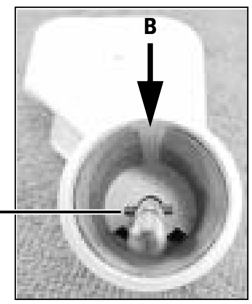
9.18.2 Replace friction pad in lower bag arm assembly

1. Remove the ABS breathing system from the machine.
2. Using an 8-mm socket, remove the nut (**A**), shoulder washer, and spring from the lower assembly.

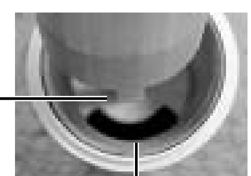


3. Lift the bag support arm off of the swivel post. Remove the old friction pad.
4. Wipe any residue and friction particles from the post.
5. Insert a new friction pad into the base. Keep approximately 1 mm of space between the end of the pad and the bottom of the base.

   Note: Align the friction pad gap with the seam (**B**) in the base. Position the retaining screw so the pin (**C**) at the base is perpendicular to the seam.



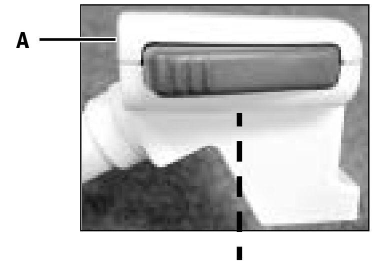
6. With the bag support arm facing forward, place the base of the arm over the swivel post. Ensure that the slot in the base (**D**) engages the tab (**E**) on the swivel post.



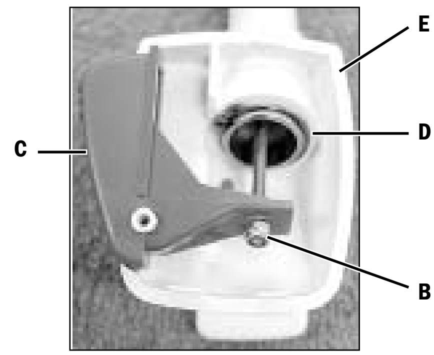
7. Replace the spring, shoulder washer and nut. Tighten the nut until 5 mm of thread extends beyond the nut.
8. Follow the procedure in Section 9.18 to adjust the force required to swing the bag arm from side to side.

9.18.3 Replace bag port housing

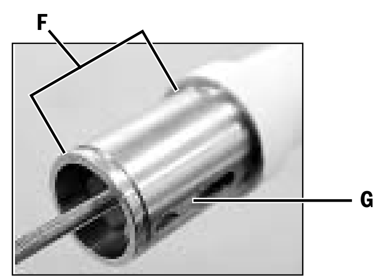
1. Remove the bag support arm cover (**A**) – screw and lockwasher from below.



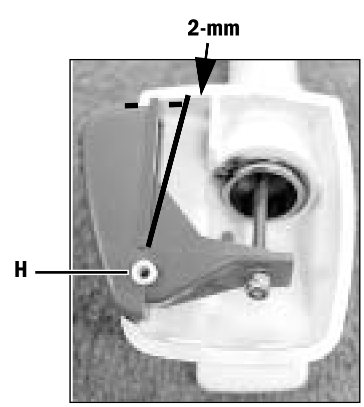
2. Remove nut (**B**) to remove the release lever (**C**).
3. Remove the retaining ring (**D**).
4. Slide the bag port housing (**E**) off the end of the bag support arm.



5. Before installing the new bag port housing, clean and lubricate sparingly with Krytox the exposed metal end (**F**) and the guide slot (**G**) of the bag support arm.

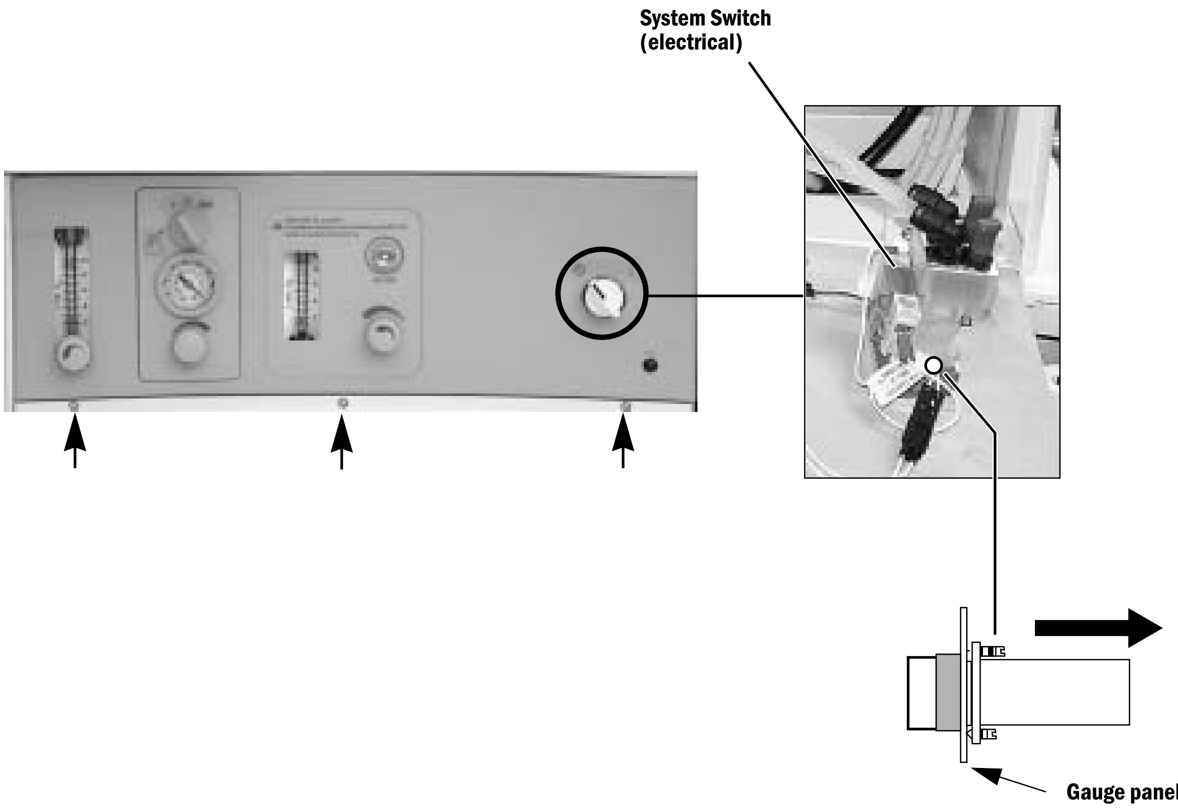


6. Slide the new bag port housing onto the bag arm. Secure it with the retaining ring.
7. Lubricate sparingly with Krytox the pivot boss (**H**) before replacing the release lever.
8. After replacing the release lever, adjust the mounting nut so that a 2-mm gap remains between the lever and housing when the release lever is fully depressed.
9. Replace the bag arm cover.



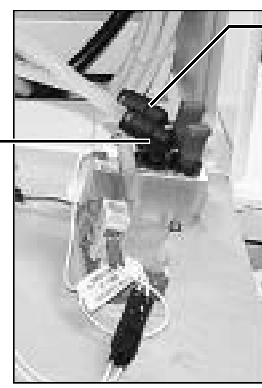
9.19 Replace system switch assembly

1. Bleed all gas pressure from the machine (Section 9.2).
2. Ensure that all cylinder and pipeline pressures read zero before proceeding.
3. Remove the tabletop (Section 9.4).
4. Remove the gauge panel mounting screws and move the panel forward to access the system switch.



5. Disconnect the wires from the electrical switch.
6. Back out the system switch mounting screws just enough to allow the knob collar to be released.
7. While holding the switch assembly, push in the knob and turn it counterclockwise.
8. Pull the knob and collar out from the front and remove the switch assembly.

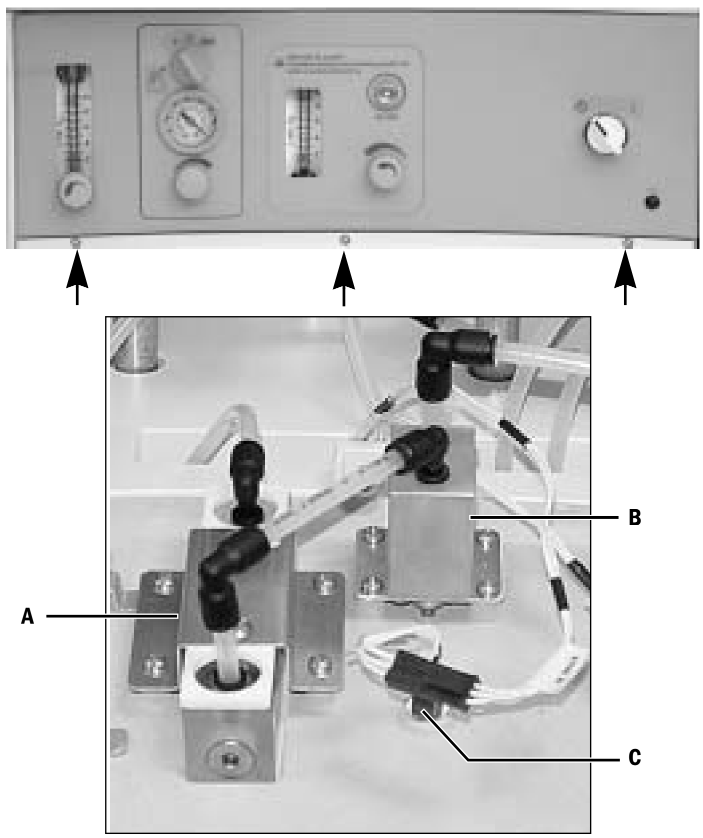
9. Install the replacement switch assembly:
   a. Transfer the 8-mm plugs from the old system switch to the new system switch on the pneumatic module (pull on the plug to ensure that it is locked into the module).
   b. Turn back the system switch mounting screws until their tips recede.
   c. Orient the switch assembly with the plugged fittings toward the right and the O_2 fittings toward the left.
   d. Install the switch assembly through the gauge panel.
   e. Push the knob collar in with the indicator up and turn it clockwise until it locks.
   f. Tighten the mounting screws. Make sure that the top edge of the switch assembly is parallel to the top edge of the gauge panel.
   g. Loosen the two outside screws on the electrical module.
   h. Insert the wires in the electrical module and tighten the screws.
   i. Pull the wires on the electrical module to ensure that there is a good connection.
   j. Transfer the tubing from the old system switch to the new system switch on the pneumatic module (pull on the tubing to ensure that it is locked into the module).



10. Test the replacement switch assembly:
    a. Connect an O_2 supply.
    b. Connect the power cable to an electrical outlet.
    c. Set the system switch to On.
    d. Make sure that the display comes On.
    e. Select Alt O_2 flow.
    f. Increase the Alt O_2 flow. Make sure that gas flows.
    g. Make sure that you do not feel or hear any leaks.
    h. Set the system switch to Standby.
    i. Make sure all gas flow stops and the display turns Off.
11. Reinstall the gauge panel and the tabletop.
12. Perform the checkout procedure (Section 3).

9.20 Replace Alt O_2 components

1. Bleed all gas pressure from the machine (Section 9.2).
2. Ensure that all cylinder and pipeline pressures read zero before proceeding.
3. Remove the tabletop (Section 9.4).
4. Remove the gauge panel mounting screws and move the panel forward to access the Alt O2 components.



Alt O_2 Flowmeter (A)

Disconnect the tubing from the flowmeter.
Remove the four screws that hold the flowmeter mounting bracket to the front panel.
Transfer the mounting bracket to the new flowmeter.

Needle Valve Assembly (B)

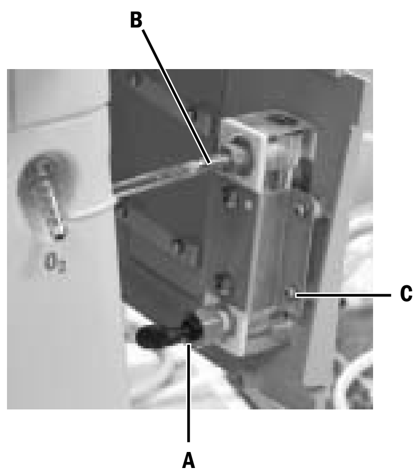
Loosen the set screw that holds the knob to the needle valve; remove knob.
Disconnect the tubing from the needle valve assembly.
Remove the four screws that hold the needle valve assembly to the front panel.
Transfer the mounting plate to the new needle valve assembly.

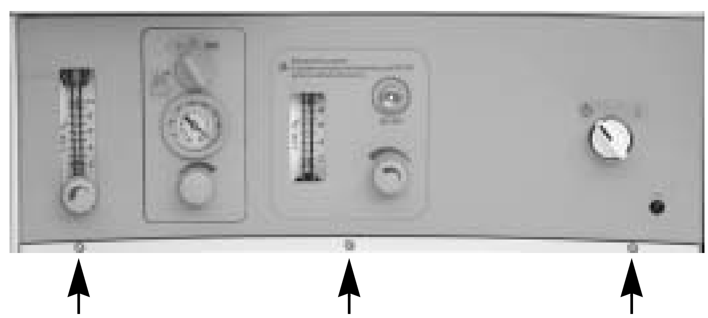
Alt O_2 Switch (C)

Disconnect the switch harness.
When replacing the switch, face the tab on the washer toward the switch body (tab not used for positioning).

9.21 Replace auxiliary O_2 flowmeter

1. Bleed all gas pressure from the machine (Section 9.2).
2. Ensure that all cylinder and pipeline gauges read zero before proceeding.
3. Remove the tabletop (Section 9.4).
4. Remove the adjustment knob from the flowmeter; pull forward.
5. Remove the gauge panel mounting screws and move the panel forward to access the flowmeter.

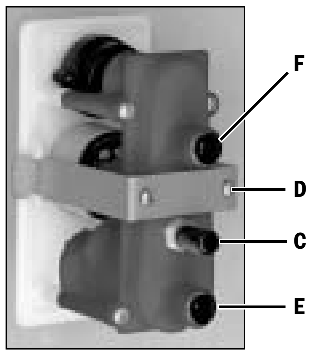


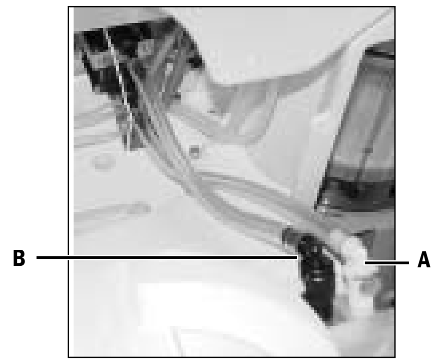


6. Disconnect the inlet tube fitting (A).
7. Disconnect the tube (B) from the outlet fitting.
8. Remove the four screws (C) that hold the flowmeter mounting bracket to the front panel.
9. Transfer the mounting bracket to the new flowmeter.
10. Reassemble in reverse order.
11. Perform the checkout procedure (Section 3).

9.22 Replace the suction regulator

1. Lower the upper rear panel (Section 9.3).
2. Disconnect the white vacuum (**A**) and black suction (**B**) fittings from the rear panel. Do not remove the tubing from the regulator.
3. If you are replacing a Venturi Drive regulator, disconnect the tube (**C**) from the control port of the regulator assembly.





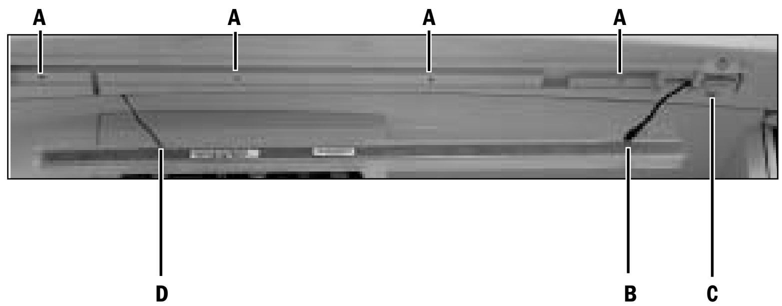
4. Disconnect the two screws (**D**) that hold the regulator assembly to the mounting bracket.
5. Remove the regulator assembly from the front panel.
6. Transfer the tubing to the new regulator:
   - Attach the vacuum source tube (white fitting) to the lower connector (**E**).
   - Attach the suction tube (black fitting) to the upper connector (**F**).
7. Guide the tubes into the front panel opening.
8. While holding the regulator assembly against the front panel, attach the retaining bracket to the regulator. Tighten the screws to secure the regulator assembly.
9. If applicable, attach the control port tube to the regulator assembly (**C**).
10. Attach the vacuum and suction fitting to the rear panel manifold.
11. Replace the rear panel.
12. Perform the checkout procedure (Section 3).

9.23 Replace task light components

The Avance machine includes two task lights (upper and lower) that are controlled by a common switch. The task light switch and the upper tack light are accessible from the front of the machine. To service the lower task light you have to remove the rear panel.

9.23.1 To replace the task light switch

1. Remove the four screws (**A**) that hold the task-light lens to the upper shelf.



2. Using a small needle-nose pliers, disconnect the switch harness from the task-light circuit board connector (**B**).
3. Remove the two screws (**C**) that hold the switch retainer plate to the upper shelf.
4. Transfer the switch retainer plate to the new switch, counter-sunk side to the outside.
5. Mount the switch to the upper shelf.
6. Remount the task-light assembly. Ensure that the switch harness and the task-light harness wires are positioned in their respective recesses and are not pinched under the task-light lens.

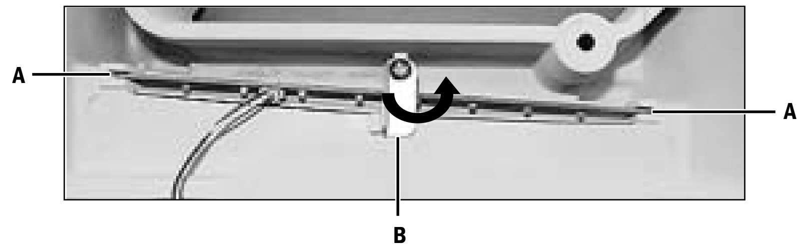
9.23.2 To replace the upper task light

1. Using a small needle-nose pliers,
   - disconnect the switch harness from the task light circuit board connector (**B**).
   - disconnect the task-light harness from the task light circuit board connector (**D**).
2. Slide the task-light circuit board out of the lens.
3. Slide the new task light into the lens, ensuring that the connectors are aligned with the lens cutouts.
4. Plug the task-light harness and the switch harness into their respective connectors on the task-light circuit board. Use a small screwdriver to push the connectors securely into place.
5. Remount the task-light assembly. Ensure that the switch harness and the task-light harness wires are positioned in their respective recesses and are not pinched under the task-light lens.

9.23.3 To replace the lower task light

1. Remove the rear panel (Section 9.3.1).

   The lower task light is located directly below the MGAS partition. It slides into two slots in the front bezel (**A**) and is retained with a small moveable bracket (**B**).



2. Rotate the retaining bracket counterclockwise to free the tack light assembly.
3. Disconnect the harness from the task light assembly and connect it to the new task light.
4. Place the task light into the slots (lights pointing down).

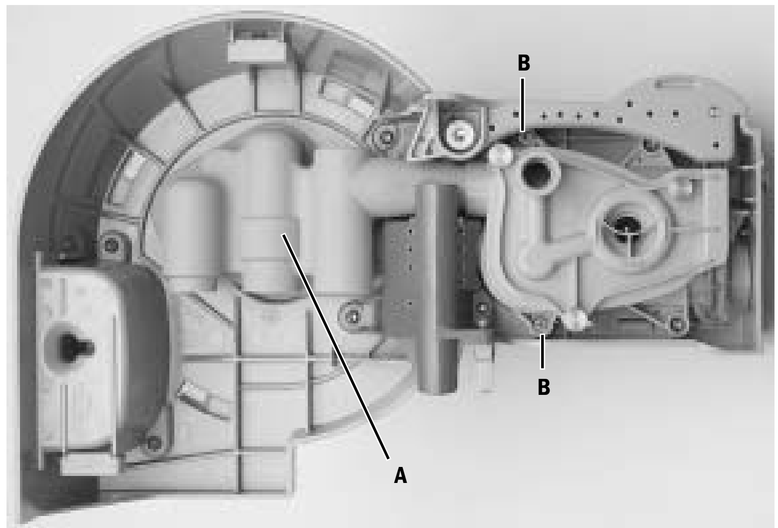
Note If the machine includes an integrated suction regulator, it may be too cramped for you to place the task light. Use long-nose pliers or a similar tool to guide the task light in place, being careful not to damage the lights. Or you can temporarily remove the suction regulator to gain more room.

5. Rotate the bracket in place to retain the task light.
6. Reassemble in reverse order.

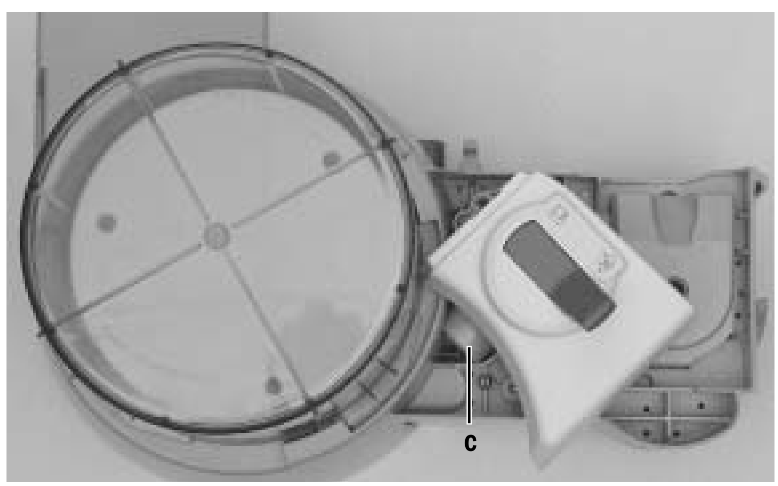
9.24 Replace ABS breathing system components

9.24.1 Replace Bag/Vent switch assembly

1. Remove the ABS breathing system.
2. From the underside, remove the bellows base manifold (**A**) and fully loosen the two captive screws (**B**) at the bag port side of the APL/BTV manifold.



3. From the topside, rotate the Bag/Vent switch cartridge counterclockwise until the Bag/Vent switch outlet port (**C**) clears the bellows housing.

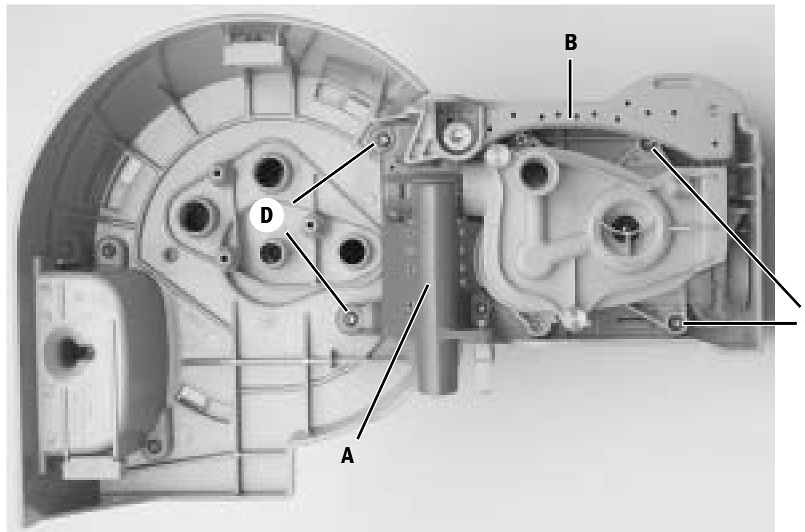


4. Lift out the Bag/Vent switch cartridge from the housing.
5. Replace the Bag/Vent switch cartridge in reverse order.
6. Reinstall the ABS breathing system.
7. Perform the checkout procedure (Section 3).

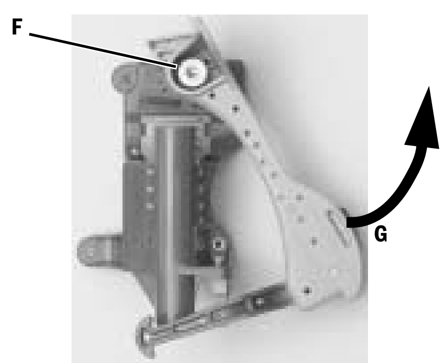
9.24.2 Replace bellows base latch assembly

To replace the latch assembly, you must disassemble the bellows base assembly to the point where you can remove the guide (**A**) and latch assembly (**B**) as a unit.

1. Remove the Bag/Vent switch cartridge (Section 9.24.1).
2. Remove the two remaining screws (**C**) that hold the APL/BTV manifold to the bellows base assembly. Remove the APL/BTV manifol.



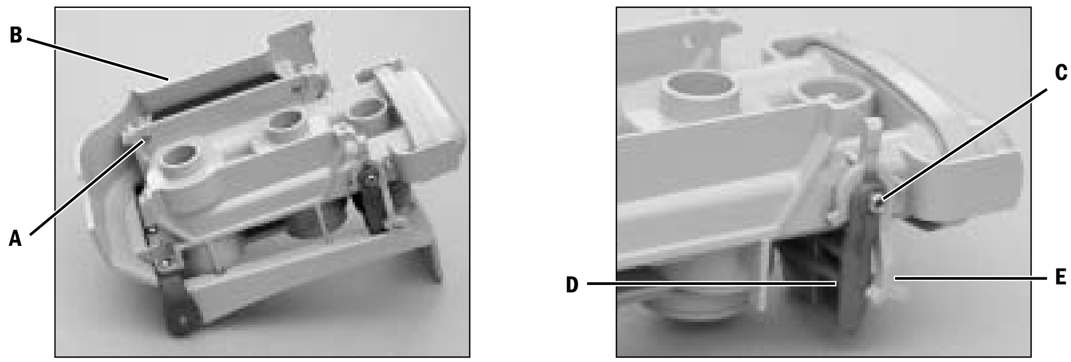
3. To remove the guide/latch assembly, remove two mounting screws (**D**) from the underside. Remove two additional mounting screws from the topside. Remove the guide/latch assembly from the bellows base assembly.
4. Separate the latch assembly from the guide assembly.
5. To install the new latch assembly, put the spring (**E**) into place in the guide assembly (long leg down).
6. Place the latch assembly on the guide assembly so that the latch engages the short leg of the spring. Secure the latch assembly (**F**) to the guide assembly.



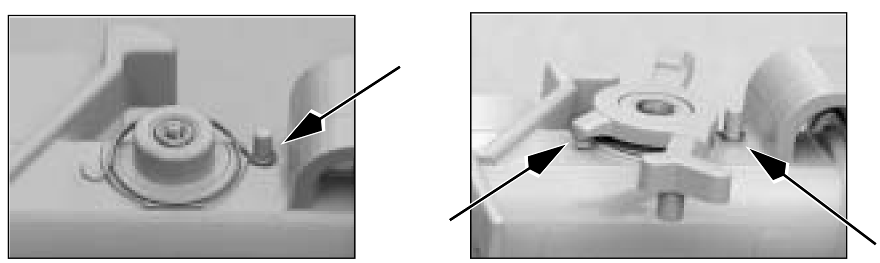
7. Mount the guide/latch assembly into the bellows base assembly.
   - Extend the latch (**G**) while placing the assembly into the base.
8. Reassemble the breathing system in reverse order.
9. Perform the checkout procedure (Section 3).

9.24.3 EZchange Canister spring replacement

1. Detach the EZchange module from the machine.
2. Remove the two M3 screws (**A**) that hold the module cover (**B**); set the cover aside.



3. Remove the two M3 shoulder screws (**C**) that fasten the canister latch lever (**D**).
4. Remove the latch lever, the switch actuator lever (**E**) and the spring; discard the spring.
5. Place the new spring on the module (as shown below). Position the switch actuator lever over the spring. Ensure the spring hooks are fully engaged into the posts on the manifold and the actuating lever.



6. Clean any residual Loctite debris from the M3 shoulder screws removed in Step 3.
7. Place the canister latch lever in position. Apply Loctite 242 to the threads of the two M3 shoulder screw threads and secure the canister latch level.
8. Check the switch actuator lever to ensure free movement. If sticking is observed, loosen the M3 shoulder screw approximately 1/8 of a turn until free movement of the switch actuator lever is observed.
9. Install the module cover.
10. Install the EZchange module.
11. Verify that the following message appears on the screen when the absorber canister is released.
    - 'No CO2 absorption' for Aespire machines
    - 'CO2 Absorber Out of Circuit' for Avance and Aisys machines
12. Perform the Preoperative Checkout Procedure (refer to the User's Reference manual).

9.25 Replace casters

⚠ **WARNING** Replacing a caster requires at least two people to maneuver and tip the machine. Personal injury and/or machine damage is possible if one person attempts this procedure alone.

1. Disconnect all pipeline hoses from the wall and the machine, close all gas cylinders, unplug the power cord, and set the system switch to standby.

⚠ **CAUTION** Remove the vaporizers before tipping the machine. If a vaporizer is inverted, it must be set to 5% and purged for 30 minutes with a 5 L/min flow. The interlock system prevents purging more than one vaporizer at a time.

2. Remove the absorber, the vaporizers, gas cylinders, drawers and all auxiliary equipment.

⚠ **CAUTION** To prevent damage, do not tip the Avance machine more than 10 degrees from vertical.

3. Block the opposite wheels; then, block up the machine until there is enough room to remove the defective caster.

   To block up the machine, tip and slide blocks under the caster base. Raise both sides evenly until the unit is high enough to remove the caster.

4. The casters are threaded into the base and held with a Loctite compound. Remove the caster with an appropriately sized open-end wrench.

5. If required, clean the threads of the new caster with denatured alcohol.
6. Apply Loctite 242 to the threads of the new caster. Install the caster securely into place.
7. Make sure the caster turns freely.
8. Carefully lower the machine to the floor.
9. Perform the checkout procedure (Section 3).

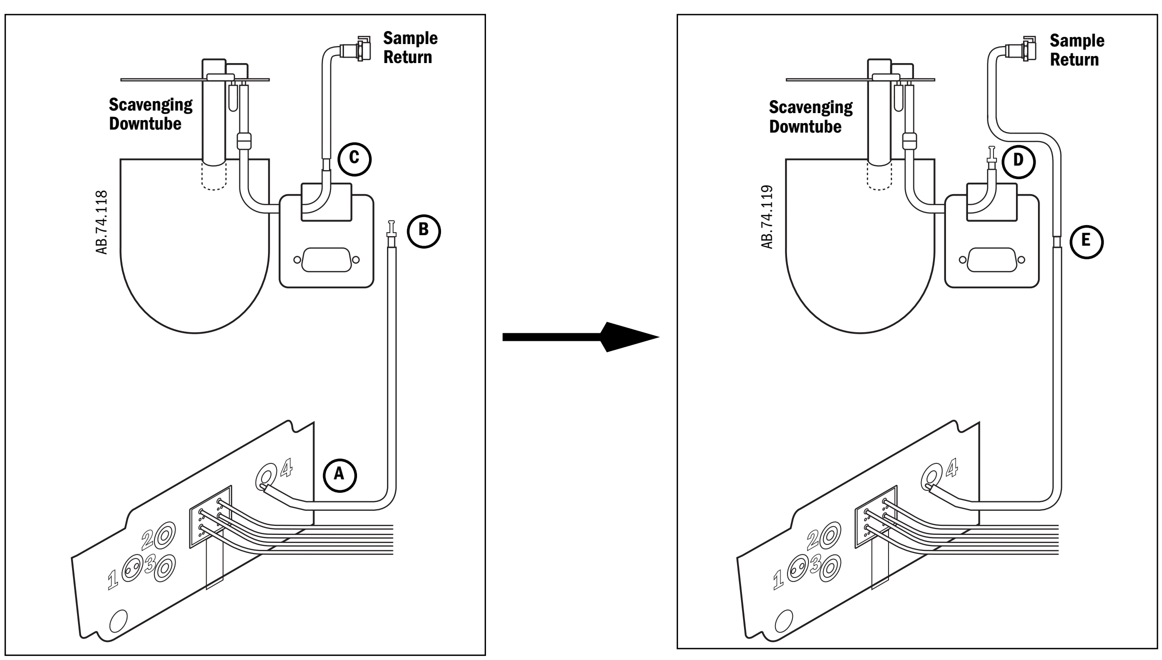
9.26 Reconfigure sample gas return line

Note In the U.S., it is not permitted to return sample gas to the breathing circuit.

Outside the U.S., consult with hospital guidelines on filtering of re-breathed gas before allowing the sample gas return line to be reconfigured.

Procedure Sample gas return is directed to the scavenging system as a factory default. Perform the following to reroute the sample gas back to the breathing system.

1. Remove the tabletop.
2. Port 4 (**A**) of the ABS breathing system is connected to the expiratory circuit, downstream of the expiratory check valve. As a factory default, Port 4 is plumbed with a length of tubing that is plugged (**B**) at the far end.
3. Remove the plug from the tube.
4. Find the sample return line at the left-rear corner of the pan assembly. The sample return line includes an inline connector (**C**) at the point where the sample line goes down into the vent engine housing.
5. Separate the scavenging tube, removing the inline connector from the portion of the tube that extends into the vent engine housing. Plug the open end of the scavenging tube (**D**) with the plug removed above.
6. Insert the inline connector from the sample return port into the open end of the return tube (**E**) to Port 4. Pull on the connector to ensure that it is securely connected.
7. Replace the tabletop.
8. Perform the checkout procedure (Section 3).



9.27 Change drive gas

⚠ **CAUTION** If you change the drive gas, you must also change the drive gas selection on the ventilator service setup screen. Refer to Section 4 of the ventilator Technical Reference manual.

- If the drive gas selection and the actual drive gas do not agree, volumes will not be correct.

The ventilator will alarm with the message “Low Drive Gas Press” if the selected drive gas pressure, either O_2 or Air, is lost.

1. Remove the rear panel (Section 9.3).

Note: The O_2 and Air pipeline manifolds have a drive gas connection at the back. The connection not in use is plugged.

2. Remove the plug from the new connection.
3. Disconnect the drive gas hose from the present connection.
4. Install the plug in this connection (pull on the plug to ensure that it is locked into the fitting).
5. Reroute the drive gas hose so that it does not cause kinks in other tubing.
6. Connect the drive gas hose to the new connection (pull on the hose connector to ensure that it is locked into the fitting).
7. Do a high-pressure leak test (Section 3.8).
8. Enter the service mode and select the correct drive gas.
9. Test the primary regulator. Verify that it functions within specifications now that it will be supplying drive gas to the ventilator (Section 5.1).
10. Perform the checkout procedure (Section 3).

10 Illustrated Parts

In this section

10.1 Service tools

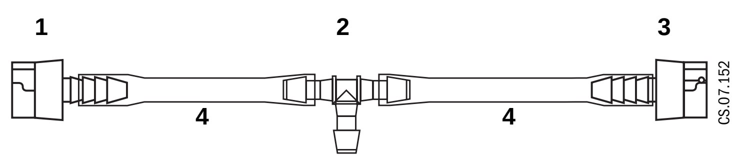
10.1.1 Software tools

Item	Description	Version	Stock Number
1	Avance System Software (for HPDU)	5.X 4.X	M1087631-S M1062100-S
1	Avance System Software (for DU)	3.20 3.00 2.02	M1055796 1009-6163-000 1009-6135-000
2	Compact Flash adapter, PCMCIA carrier (required only for DU)		1009-5874-000
3	Service Application, PC based (for System Software 5.X)	1.X	M1088110
3	Cable, DU serial port to PC serial port		1011-3984-000

10.1.2 Manifold pressure test adapter

The manifold pressure test adapter is used to tee into the manifold pressure line for the Manifold P Span calibration (Section 5.4.2).

Assemble the adapter using the parts shown.



Item	Description	Stock Number
1	Coupler, male - white	1503-3236-000
2	Tee (male barb)	1009-3011-000
3	Coupler, female - white	1503-3119-000
4	Tubing (low-pressure) 1/4 inch	1605-1001-000

10.1.3 Test Devices

Item	Tool	Stock Number
1	Test flowmeter, 6–50 L/min (Suction Flow Test)	1006-8431-000

1

Not Shown

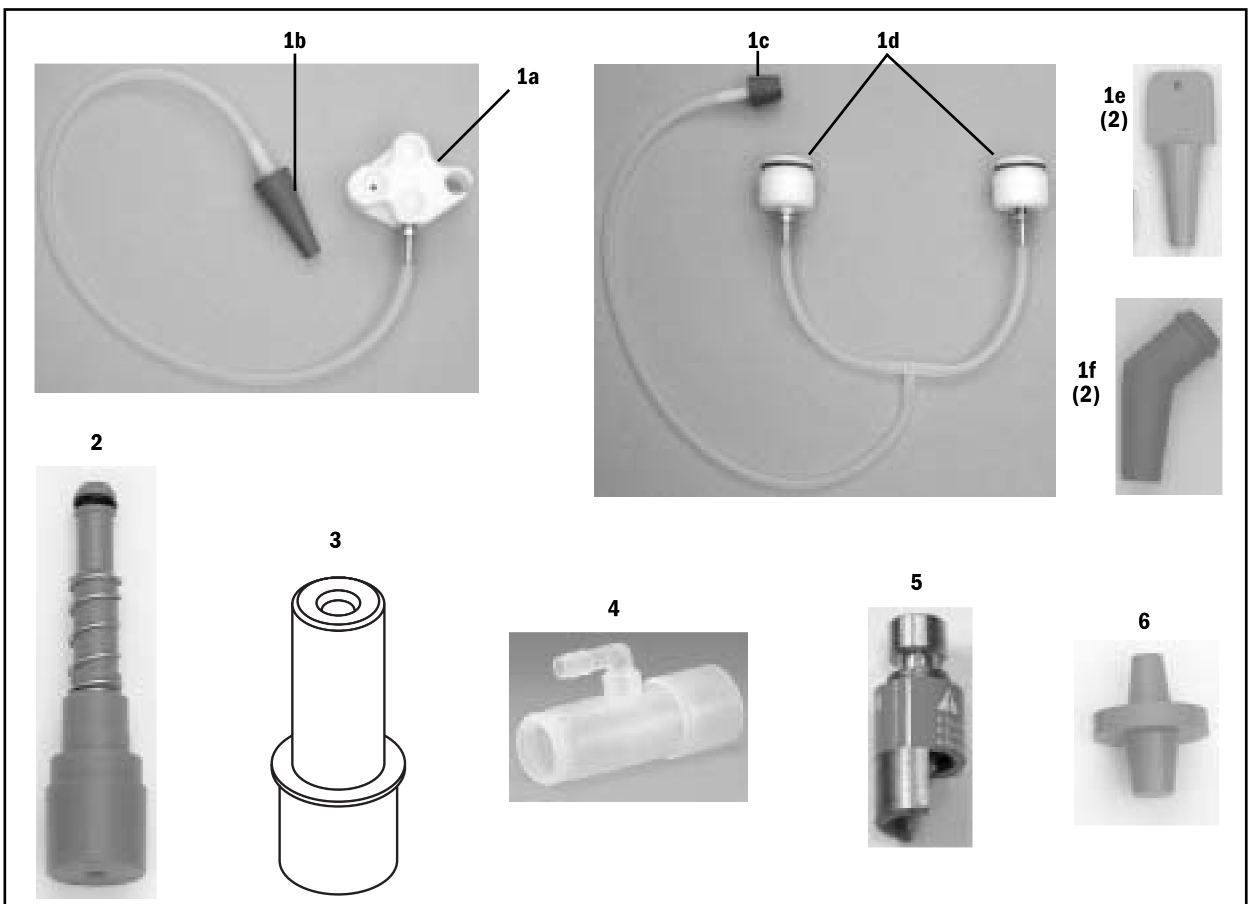
Low-pressure Leak Test Device	(negative pressure)	0309-1319-800
Low-pressure Leak Test Device	(positive pressure - ISO)	1001-8976-000
Low-pressure Leak Test Device	(positive pressure - BSI)	1001-8975-000
Flow test device capable of measuring 0–15 L/min with an accuracy of ±2% of reading		Refer to section 6.7
Vacuum test gauge capable of measuring 0 to 550 mm Hg with an accuracy of ±1% of reading		Refer to section 6.9
Test device capable of measuring 0–30 L/min (see Item 1 above)		Refer to section 6.9
Leakage current test device		Refer to section 3.16
Test device capable of measuring 689 kPa (100 psi)		Refer to section 5.1.1

10.1.4 Lubricants and Adhesives

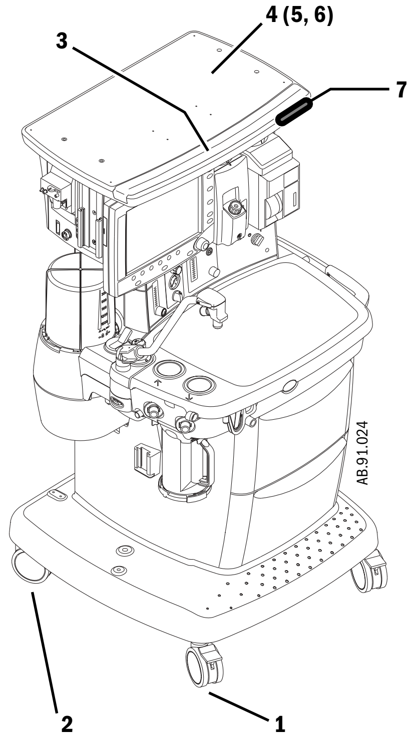
Item	Description	Stock Number
1	Lubricant, Krytox GPL 205, 2 oz	1001-3854-000
2	Lubricant, Dow 111, 5.3 oz	6700-0074-200
3	Thread Lock, Loctite No 24221, 10 ml	0220-5017-300
4	“Super Glue Gel”, Loctite 454	6812-2160-010

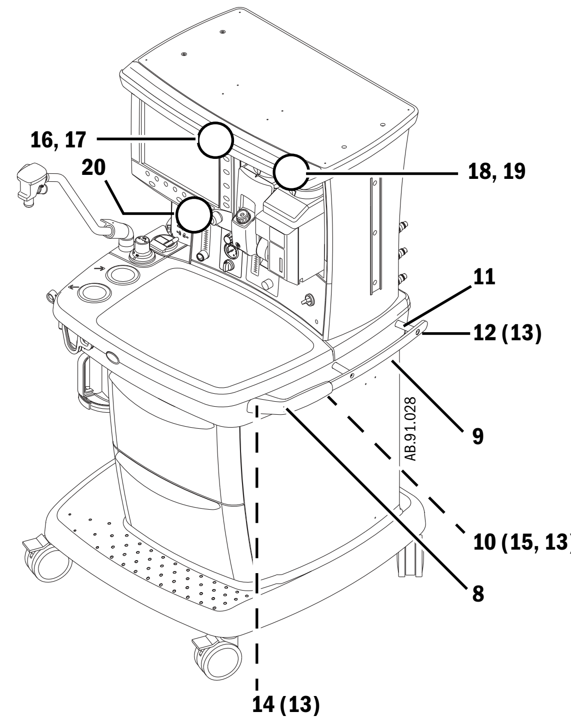
10.1.5 Test Tools

Item	Tool	Stock Number
1	Leak Test Tool Kit, ABS breathing system	1407-7013-000
1a	Test Tool, bulkhead	1407-8500-000
1b	Plug, tapered 27x12 mm	1407-8505-000
1c	Plug, tapered 24x18 mm	1407-8506-000
1d	Test Tool, circle module (2 each)	1407-8502-000
1e	Plug, service B/S 11 mm (2 each)	1407-8504-000
1f	Plug, service BTV 18 mm (2 each)	1407-8503-000
2	Adapter, positive low-pressure leak test	1009-3119-000
3	PEEP/INSP Calibration Flow Orifice	1504-3016-000
4	Airway Pressure Sensing Tee	1504-3011-000
5	Vaporizer Manifold Valve Test Tool	1006-3967-000
6	Plug, stopper	2900-0001-000
Not Shown		
	Tool to help disconnect tubing from Legris fittings	2900-0000-000
	Test Lung	0219-7210-300
	Leak detection fluid, Snoop	obtain locally



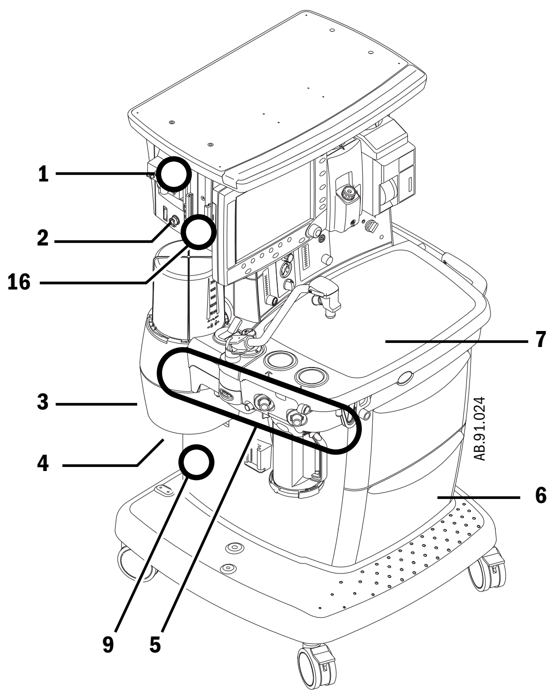
10.2 External components - front view

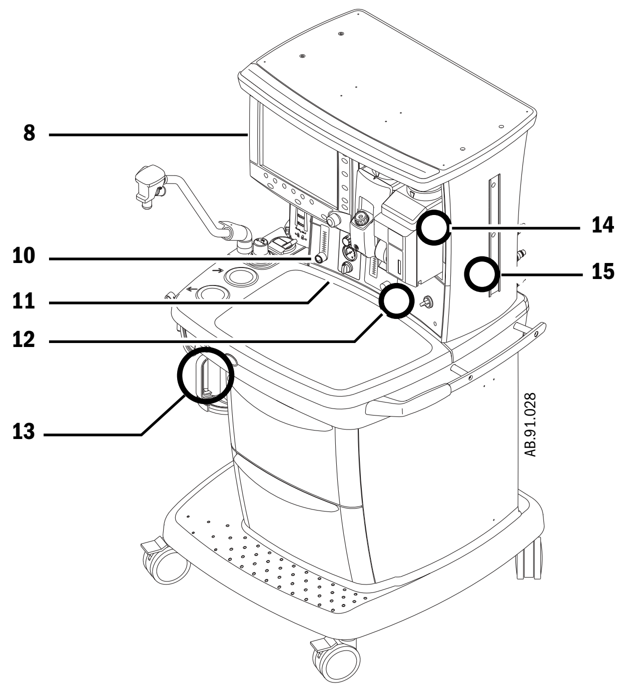




Item	Description	Stock Number
1	Caster, 125-mm with brake (front)	1006-3070-000
2	Caster, 125-mm no brake (rear)	1006-3071-000
3	Cover, cable channel	1009-3020-000
4	Upper shelf	1009-3022-000
5	Bolt, M6x40	0144-2131-911
6	Lockwasher, M6 internal	0144-1118-130
7	Label, S/5 Avance	1009-3206-000
8	Handle, side	1009-3033-000
9	Handle, Medirail	1009-3101-000
10	Screw, M6x12 Sems	0144-2436-106
11	Spacer	1009-3102-000
12	Screw. M6x70	0144-2131-923
13	Lockwasher M6 external	9213-0560-003
14	Screw, M6x20	0144-2131-921
15	Shim	1009-3131-000
16	Task Light PCB, Upper	1009-5855-000
17	Lens, Task Light	1011-3308-000
	Screw	0142-4254-106
18	Switch Assembly, task light	1009-5587-000
19	Plate, switch mounting retainer	1009-3143-000
	Screw	0140-6226-107
20	Task Light PCB, Lower	1009-5857-000

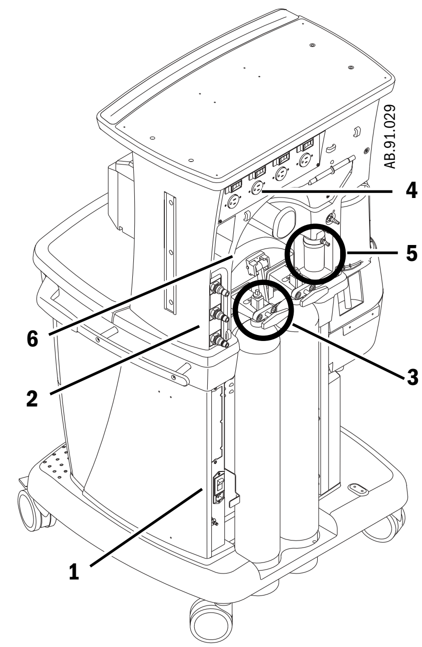
10.3 External components - front view references





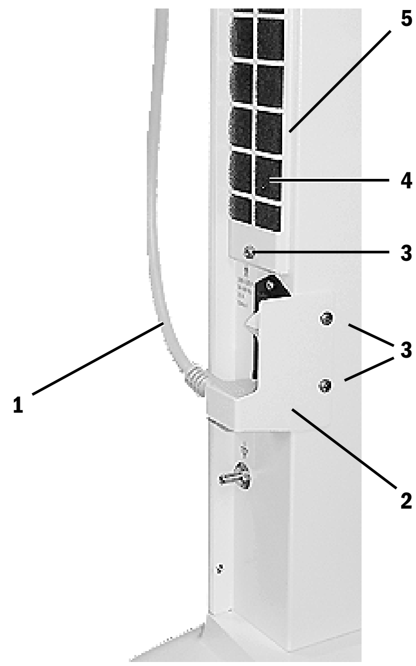
Item	Description	Section number
1	Airway module (MGAS) components	Refer to section 10.22.17
2	“AGSS gauge, and sample return”	Refer to section 10.22.16
3	Vent Engine Housing	Refer to section 10.15
4	Anesthetic Gas Scavenging System — AGSS	Refer to section 10.22.12
5	Breathing System	Refer to section 10.22
6	Drawer	Refer to section 10.29
7	Tabletop components	Refer to section 10.26
8	Display Unit (DU)	Refer to section 10.7
9	External components - lower assembly	Refer to section 10.28
10	Auxiliary O_2 Flowmeter	Refer to section 10.24
11	Integrated Suction Regulator	Refer to section 10.23
12	Front panel, Alt O2, and system switch	Refer to section 10.20
13	ABS to machine Interface Components (SCGO)	Refer to section 10.17
14	Vaporizer manifold	Refer to section 10.14
15	Right-side Components	Refer to section 10.27
16	Optional Monitor Display mounts	Refer to section 10.37

10.4 External Components - rear view



Item	Description	Stock Number
1	AC Inlet	Refer to section 10.5
2	Pipeline Inlets Label, pipeline inlet blank	Refer to section 10.12 1009-3197-000
3	Cylinder Gas Supplies	Refer to section 10.13
4	Electrical Power Outlet	Refer to section 10.6
5	Suction items	Refer to section 10.23
6	Rear panel items	Refer to section 10.25

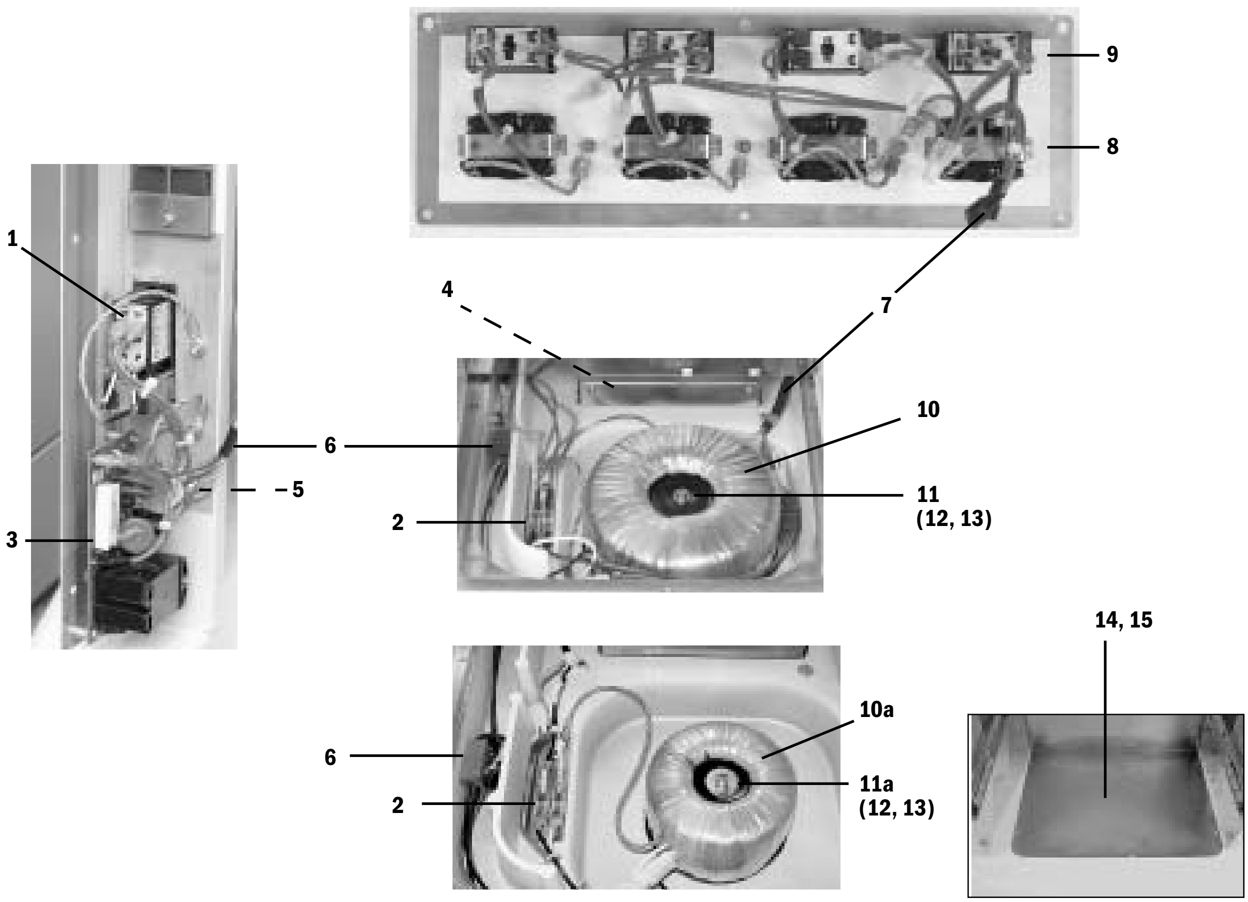
10.5 AC Power cords and AC Inlet filter



Item	Description		Stock Number
1	Power Cord		
	100-120V~ 50-60Hz, NEMA, Japan and US		1006-3907-000
	220-240V~ 50-60Hz, AS 3112, Australia		1006-3888-000
	220-240V~ 50-60Hz, GB2099, China		M1053942
	220-240V~ 50-60Hz, BS1363, UK		1006-3884-000
	220-240V~ 50-60Hz, BS546, India and South Africa		1006-3885-000
	220-240V~ 50-60Hz, CEE 7/7, EURO and France		1001-3380-000
	220-240V~ 50-60Hz, Danish		1011-3696-000
	220-240V~ 50-60Hz, SEV 1011, Swiss		1006-3889-000
	220-240V~ 50-60Hz, NEMA, Peruvian		1006-3882-000
2	Clamp, power cord retainer	(all except China)	1009-3103-000
		(China)	M1054192
3	Screw, M4x8 Pozidriv DIN84		1006-3178-000
4	Filter, foam		1009-3064-000
5	Retainer, filter		1009-3058-000

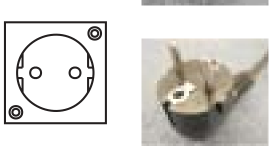
10.6 AC Inlet/Outlet Components

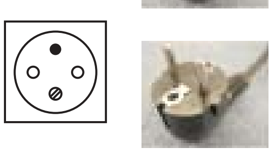
Item	Description	Stock Number
1	Inlet, 100/120 AC, with line filter and 15 A circuit breaker	1009-5698-000
	Inlet, 220/240 AC, with line filter and 8 A circuit breaker	1009-5757-000
2	Fuse, 5A - 5x20mm	1202-3345-000
	Fuse holder	1009-5674-000
3	Circuit board, Inrush, 100-120V	1006-3245-000
	Circuit board, Inrush, 220-240V	1006-3246-000
4	Filter, AC Line, 6VW1, 100-240V	1009-5690-000
5	Stud, Equal Potential, 6 mm	0208-0070-300
6	Harness, 100/120 V to Toroid	1009-5752-000
	Harness, 220/240 V to Toroid	1009-5753-000
7	Harness, to 100/120 V outlets	1009-5716-000
	Harness, to 220/240 V outlets	1009-5717-000
8	Outlet Receptacle, Australia and China, AS 3112	1001-3305-000
	Outlet Receptacle, Danish, AFSNIT 107-2-D1	1011-3910-000
	Outlet Receptacle, EURO, CEE 7/7	1202-3551-000
	Outlet Receptacle, France, CEE 7/4	1006-4421-000
	Support Frame, snap in	1006-4422-000
	Outlet Receptacle, India and South Africa, BS 546	1006-3805-000
	Outlet Receptacle, Japanese	1006-3578-000
	Outlet Receptacle, NA, Nema 5-15	1006-3555-000
	Outlet Receptacle, Swiss, SEV 1011	1006-3807-000
	Outlet Receptacle, UK, BS1363	1001-3309-000
9	Circuit Breaker, 1A, Rocker	1009-5722-000
	Circuit Breaker, 2A Rocker	1009-5721-000
	Circuit Breaker, 3A Rocker	1009-5720-000
	Circuit Breaker, 4A Rocker	1009-5719-000
10	Toroid, 100-240V	1009-5692-000
10a	Toroid, 100-240V - used with no outlets	1009-5758-000
11	Screw, M6x70	0144-2131-923
11a	Screw, M6x60	0144-2131-914
12	Lockwasher, M6	9213-0560-003
13	Washer	0402-1107-500
14	Cover, transformer	1009-3063-000
15	Screw, M4x8 DIN84 (for transformer cover)	1006-3178-000

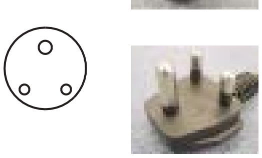



AS 3112/GB2099
Australia/China

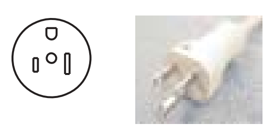

AFSNIT 107-2-D1
Danish,

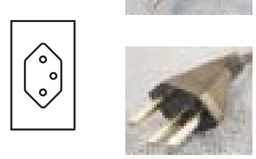

CEE 7/7
EURO

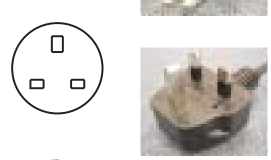

CEE 7/4
France


BS 546
India and South Africa

AA.96.228


ME2853
Japanese


SEV 1011
Swiss,


BS1363
UK


Nema 5-15
NA

10.7 Display Unit (DU)

Item	Description	Stock Number
1	Enclosure, rear	1009-5673-000
2	CPU Board, display unit (with PCMCIA frame)	1009-8289-000
3	Frame, PCMCIA	1009-5761-000
4	Gasket, knife edge (2 each)	1009-5804-000
5	Battery, Lithium 3V (positive side up)	1009-5800-000
6 (**see**	Display, LCD 12-inch color (original DG31 is obsolete)	--------------------
note)	Display (DG41), LCD 12-inch color (includes backlights)	1009-5938-000
7	Backlight Kit for DG41 display (backlight assembly, 2 inverters, and hardware)	1009-8243-000
7a	Harness, inverter	1009-5527-000
7b	Spacer, 8mm Nylon	1009-5695-000
7c	Insulator, tube	1009-3149-000
8	Grommet, diagonal cut (backlight cable)	1009-3151-000
9	Enclosure, front	1009-5672-000
10	Gasket, EMC 1.8mm OD hollow RND (2.3 m per enclosure)	1009-5802-000
11	Window	1009-5676-000
12	Encoder assembly	1503-3012-000
13	Knob, ComWheel	898794
14*	Membrane switches, right	1009-5505-000
15*	Membrane switches, lower	1009-5507-000
16	Keypad, right-side (part of keypad set)	Refer to Table 1
17	Keypad, lower (part of keypad set)	Refer to Table 1
18	Keypad, blank (part of keypad set)	Refer to Table 1
19*	Spacer, blank keypad	1009-5870-000
20	Speaker assembly, 8-ohm	1605-3263-000
21	Rear Connector Panel Assembly (with interface boards)	1009-8244-000
22	Cable, ribbon CPU to Display	1009-5520-000
23	Grommet	1009-3152-000
24	Fan, 5Vdc	1504-3516-000
25	Capsule, fan filter	896089
26	Filter, fan	897010
27	Door, PCMCIA	1009-5679-000
28	Gasket, cover plate	1009-5678-000
29**	Screw, M3x6 Sems	0140-6219-128
30**	Screw, M4x8 Sems	0140-6226-113
31**	Screw, M4x12 relieved body	1504-3001-000
32**	Lockwasher, M4 external	9213-0540-003
33**	Screw, M3x16	1504-3003-000
34**	Lockwasher, M3 external	9213-0530-003
35**	Screw, M3x6 Nylon	9211-1730-065
36**	Screw, M2x16	0140-6216-100
37	Screw, M4x12 Pan Washer HD	1009-3341-000

Stock Number
Backlight Kit
for DG 31 display
1009-8243-000

* When replacing a backlight or a backlight inverter, you must replace both inverters and the backlight assembly found in the Backlight Kit (**Item 7**).
** Keypads will likely be damaged during membrane switch replacement; order parts accordingly.
*** Refer to Table 2 for where used.

Note: Refer to Section 9.5.5 regarding backlights used in the Display Unit.

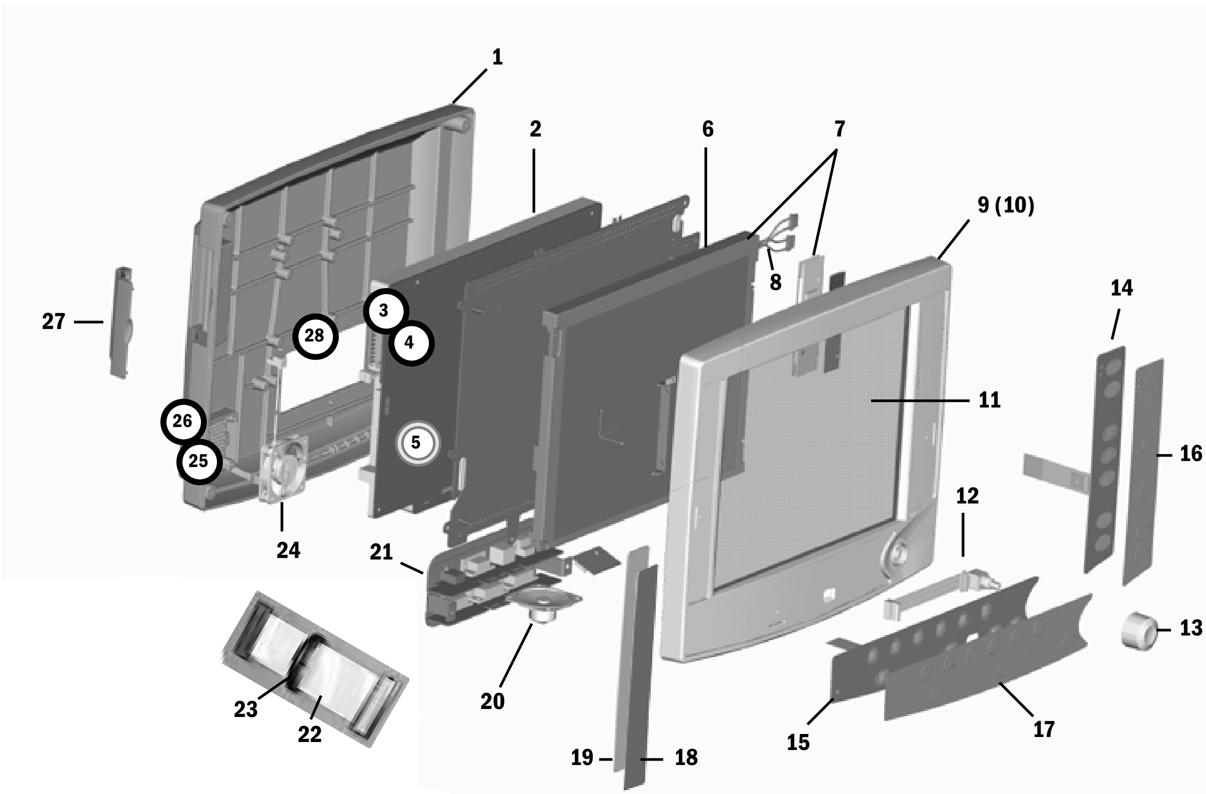
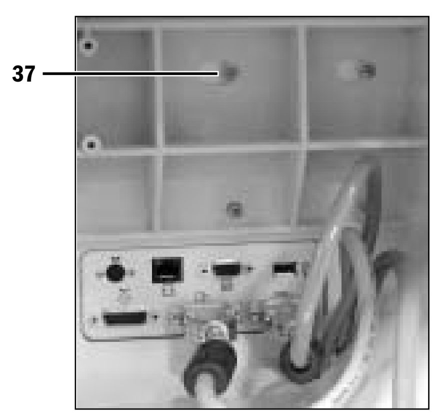


Table 1:	
Language	**Keypad Set**
Chinese	1009-5932-000
Czech	1009-5923-000
Danish	1009-5931-000
Dutch	1009-5918-000
English	1009-5915-000
Finnish	1009-5922-000
French	1009-5916-000
German	1009-5917-000
Greek	1009-5927-000
Hungarian	1009-5928-000
Italian	1009-5919-000
Japanese	1009-5929-000
Norwegian	1009-5925-000
Polish	1009-5924-000
Portuguese	1009-5921-000
Russian	1009-5930-000
Spanish	1009-5920-000
Swedish	1009-6140-000
Turkish	1009-5926-000

Table 2:
Hardware Item where used (Qty)
Speaker: 29(2)
Door: 29(2)
CPU to plate: 30(4)
Rear connector panel assembly: 30(2)
Ground straps for keypads: 30(2)
Mounting plate to Front enclosure: 30(10)
Rear enclosure: 31(4), 32(4)
Fan: 33(4), 34(4)
Inverters: 35(4)
PCMCIA frame: 36(4)



10.8 High Performance Display Unit (HPDU)

	Item	Description	Stock Number
		HPDU Assembly, complete - without keypads	1011-8084-000-S
	1	Enclosure, rear (HPDU)	1009-6089-000
	2	Gasket, cover plate	1009-5678-000
	3	Door	1009-5679-000
	4	CPU Board, HPDU	1009-5933-000
	5	Battery, Lithium 3V (positive side up)	1009-5800-000
	6	Display (DG41), LCD 12-inch color (includes backlights)	1009-5938-000
	7*	Backlight Kit for DG41 display (backlight assembly, 2 inverters, 2 insulators, and hardware)	1009-8422-000
	7a	Harness, inverter	1009-5527-000
	7b	Spacer, 8mm Nylon	1009-5695-000
	7c	Insulator, tube	1009-3149-000
	8	Grommet, diagonal cut (backlight cable)	1009-3151-000
	9	Enclosure, front	1009-5672-000
	10	Gasket, EMC 1.8mm OD hollow RND (2.3 m per enclosure)	1009-5802-000
	11	Window	1009-5676-000
	12	Encoder assembly	1503-3012-000
	13	Knob, ComWheel	898794
	14	Membrane switches, right	1009-5505-000
	15	Membrane switches, lower	1009-5507-000
	16	Membrane switches, left	1009-5506-000
	17**	Keypad, right-side (part of keypad set)	Refer to Table 1
	18**	Keypad, lower (part of keypad set)	Refer to Table 1
	19**	Spacer, blank keypad	1009-5870-000
	20	Speaker assembly, 8-ohm	1605-3263-000
	21	Connector Panel Assembly (with interface boards) - HPDU	M1056239
	22	Cable, ribbon CPU to Display	1009-5520-000
	23	Grommet	1009-3152-000
	24	Fan, 12Vdc (HPDU)	1009-6096-000
	25	Capsule, fan filter	896089
	26	Filter, fan	897010
	27	Compact Flash Card, formatted	M1055008
	28	External Compact Flash Interface Replacement Kit	M1056240
	29***	Fan, CPU - with heatsink 12V	1009-6095-000
Where Used (Not Shown)			
Speaker (2) Door (2) —	34	Screw, M3x6 Sems	0140-6219-128
Rear enclosure (4) —	35	Screw, M4x12 relieved body	1504-3001-000
Rear enclosure (4) —	36	Lockwasher, M4 external	9213-0540-003
Fan (4) —	37	Screw, M3x16	1504-3003-000
Fan (4) —	38	Lockwasher, M3 external	9213-0530-003
Inverters (4) —	39	Screw, M3x6 Nylon	9211-1730-065
CPU to plate (4) —	40	Screw, M4x8 Sems	0140-6226-113
Connector panel (2) — Ground straps, keypads (2) — Mounting plate (10) —	41	Screw, M4x12 Pan Washer HD	1009-3341-000

* When replacing a backlight or a backlight inverter, you must replace both inverters and the backlight assembly found in the Backlight Kit (**Item 7**).

** Keypads will likely be damaged during membrane switch replacement; order parts accordingly.

*** Remove (discard) the heatsink from the replacement fan before installing it onto the CPU heatsink on the HPDU CPU board (Refer to section 9.6.3).

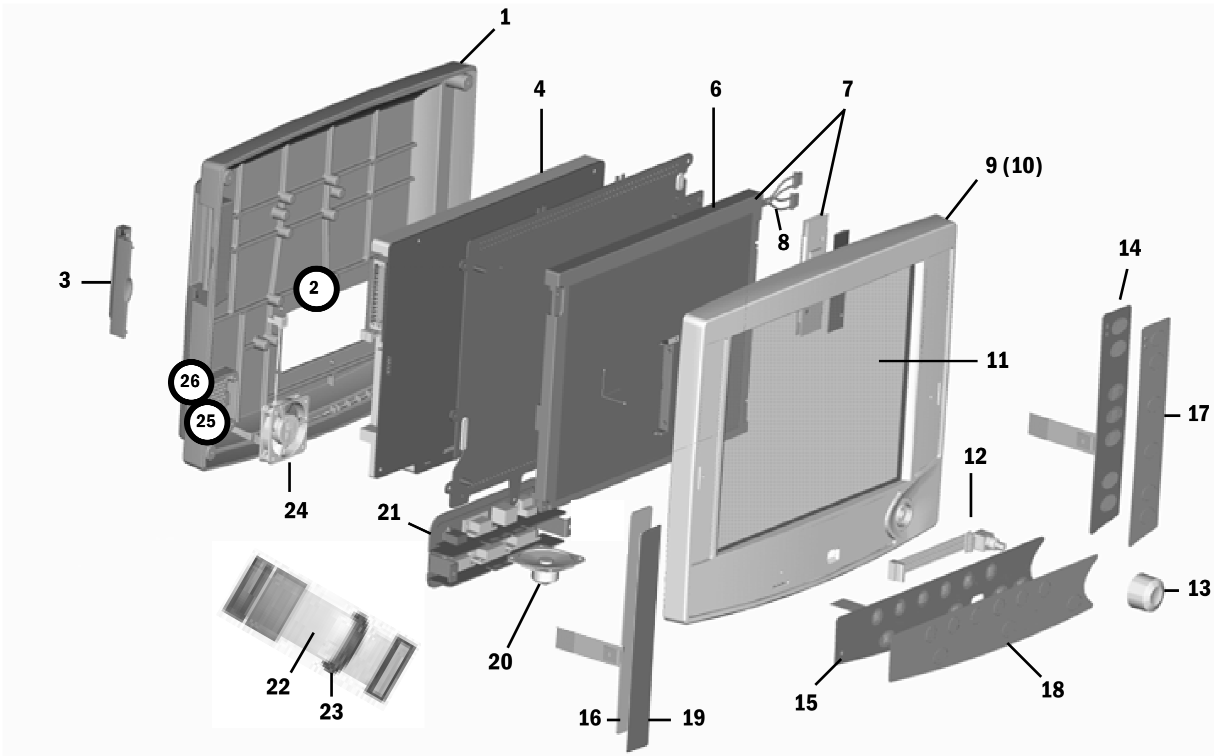
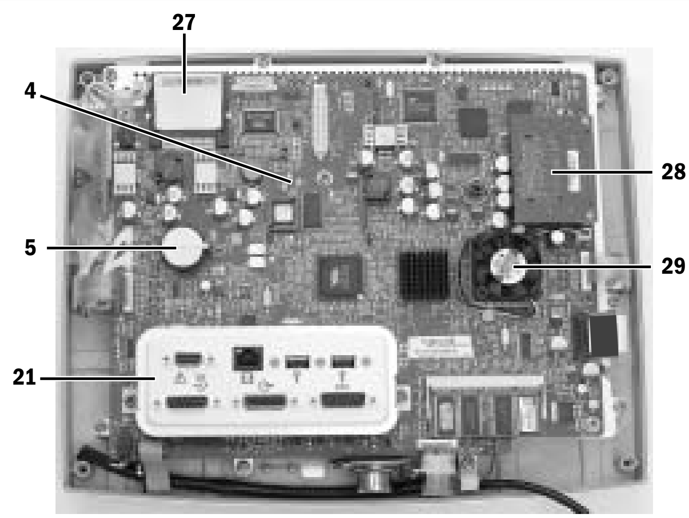
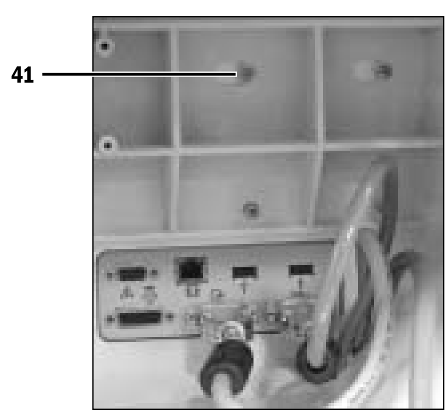


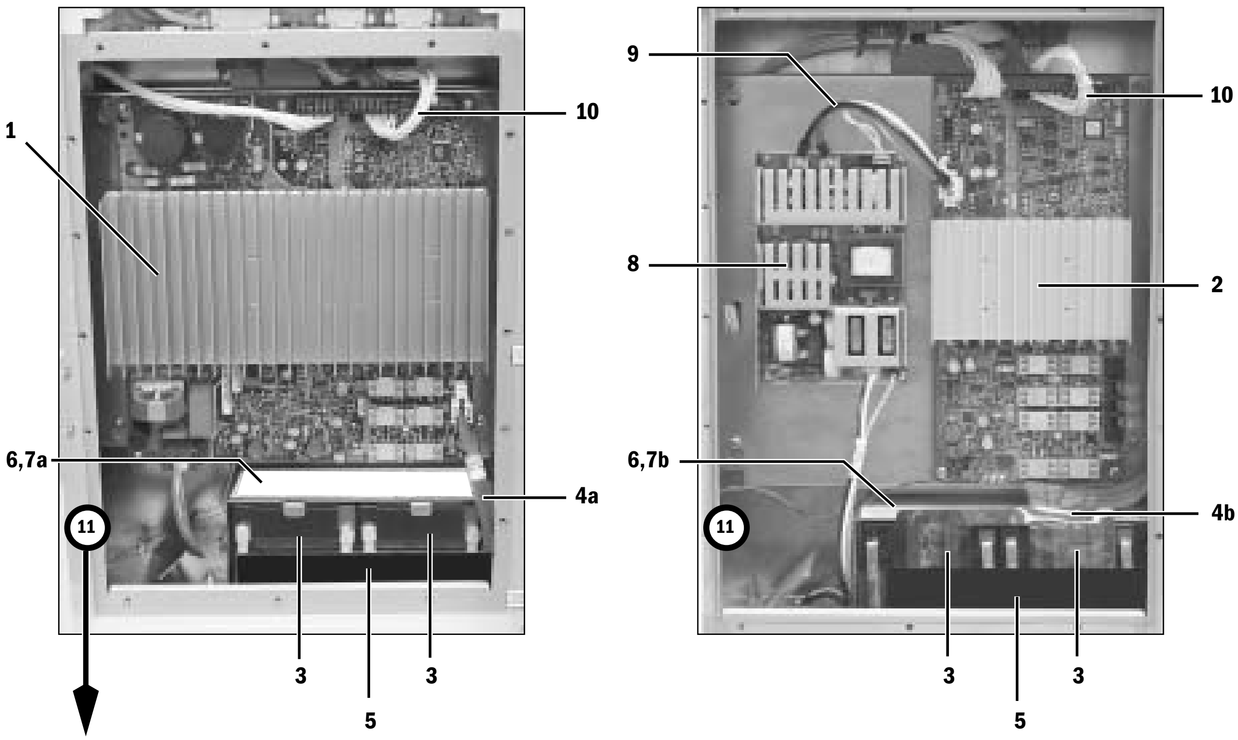
Table 1:	
Language	**Keypad Set**
Chinese	M1080398
Czech	M1080400
Danish	M1080401
Dutch	M1080404
English	M1080395
Finnish	M1080406
French	M1080423
German	M1080429
Greek	M1080431
Hungarian	M1080432
Italian	M1080434
Japanese	M1080436
Norwegian	M1080438
Polish	M1080458
Portuguese	M1080440
Russian	M1080441
Spanish	M1080443
Swedish	M1080445
Turkish	M1080448

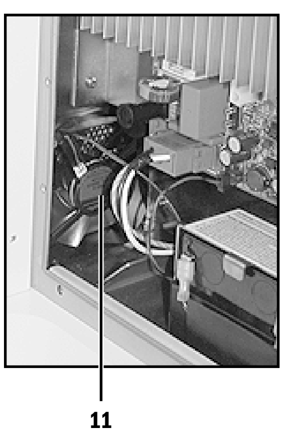




10.9 Lower electronic enclosure components

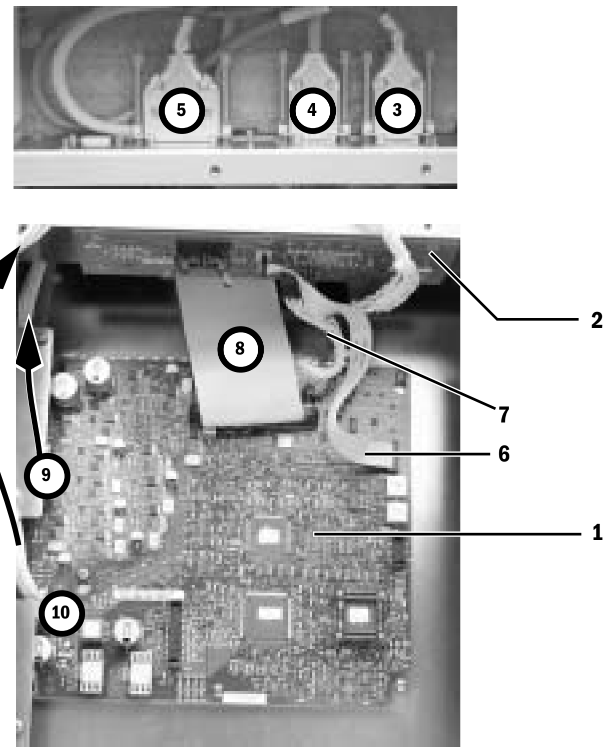
(original) (U-Frame/PCB)





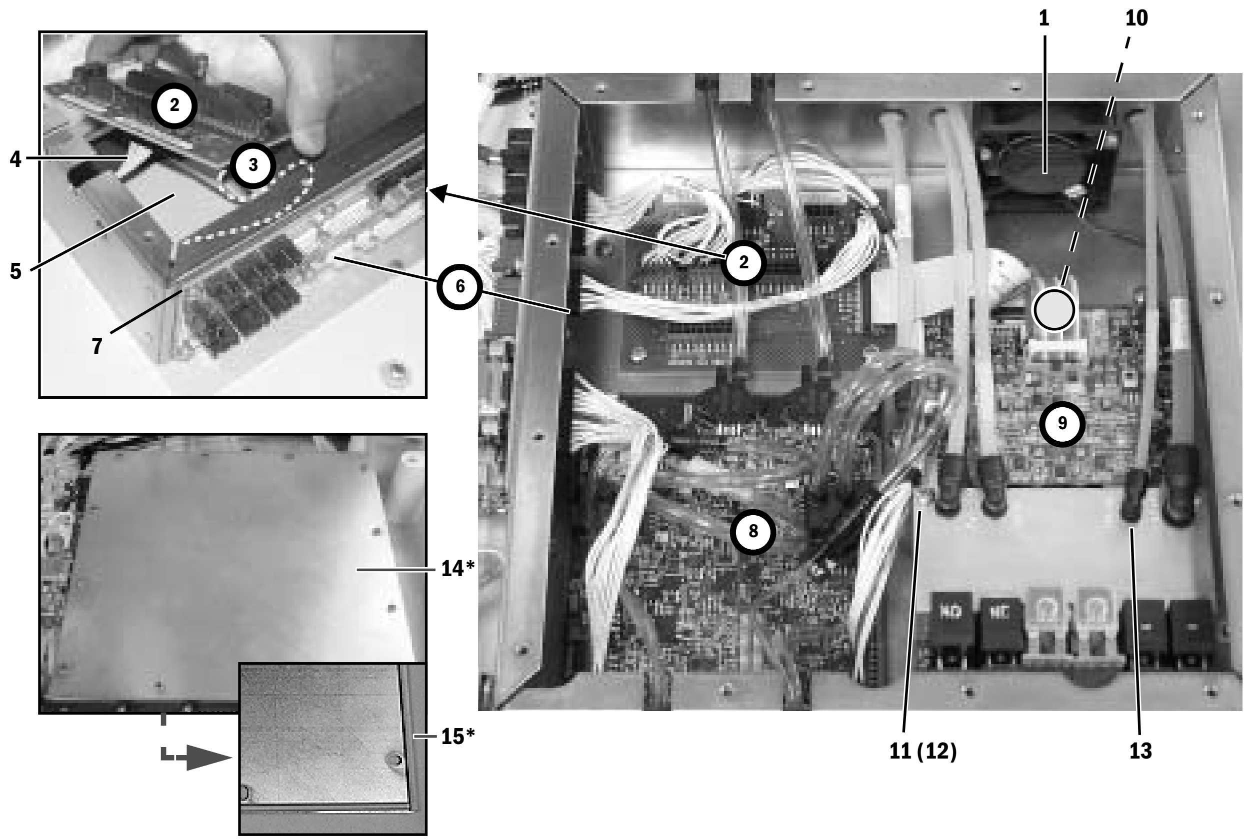
Item	Description	Stock Number
1	Power Controller board (with mounting plate) Replacement Kit	1009-8290-000 M1052795
2	Power Controller board (used with U-Frame)	1011-3572-000-S
3	Battery, sealed lead acid, 12V 4AH	1009-5682-000
4a 4b	Harness, battery Cable, Flex, Battery 4Ah Fused	1009-5557-000 M1049280
5	Tray, battery	1009-3133-000
6	Bracket, battery restraint	1009-3060-000
7a 7b	Label, battery service instructions (harness) Label, battery service Instructions (flex-cable)	1009-5530-000 M1052828
8	Power Supply, universal 150W	M1052831
9	Harness, power supply to PCB	M1049276
10	Harness, J3-PCB to J5-DCB	1009-5552-000
11	Fan (flow into enclosure)	1009-5697-000

10.9.1 Anesthesia Control and Display Connector board



Item	Description	Stock Number
1	Anesthesia Control board (tested)	1009-8291-000
2	Display Connector Board	1009-3005-000
3	Cable, to Display Unit system power interface	1009-5571-000
4	Cable, to Display Unit system signal interface	1009-5572-000
5	Cable, to Airway Module power supply	1009-5555-000
6	Cable, ribbon J2-ACB to J9-DCB	1009-5561-000
7	Harness, J7-ACB to J6-DCB	1009-5556-000
8	Cable, ribbon J1-ACB to underside of Pan Connector Board	1009-5549-000
9	Harness, J3-ACB to underside of Pan Connector Board	1009-5560-000
10	Harness, J4-ACB to J4-PCB	1009-5551-000

10.10 Pan electronic enclosure components



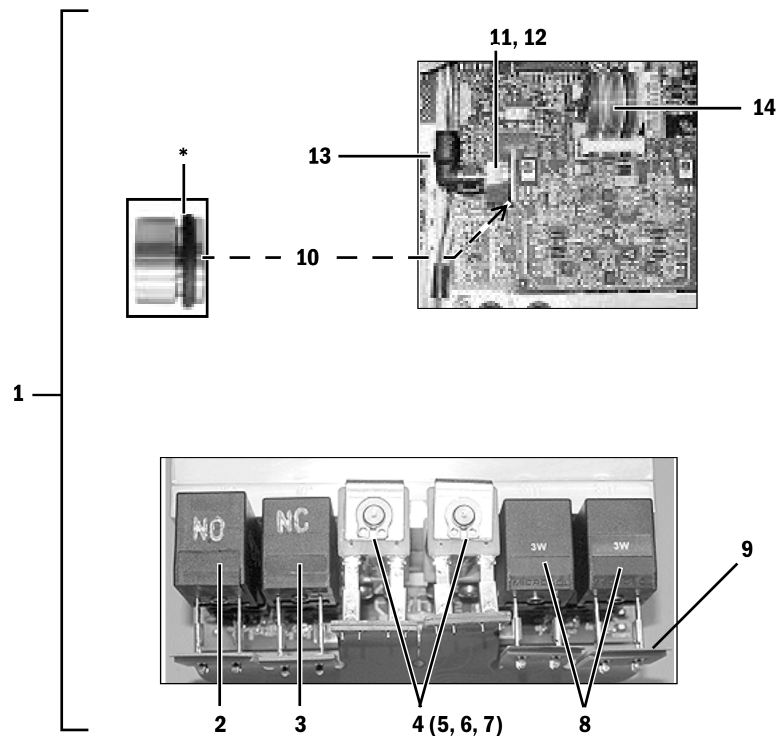
Item	Description	Stock Number
1	Fan (flow into enclosure)	1009-5680-000
2	Pan Connector Board	1009-3003-000
3	Gasket, Pan Connector Board	1009-5536-000
4	Harness, to J3-ACB	1009-5560-000
5	Cable, ribbon to J1-ACB (fold excess cable into pan area)	1009-5549-000
6**	Filter Board, ABS	1009-3007-000
7	Gasket, EMI 272 mm (2 each required per board)	1009-5811-000
8	Ventilator Interface Board, calibrated	1009-8236-000
9	Gas Mixer Assembly, complete	Refer to section 10.11
10	Screw, M4x6	1009-3283-000
11	Screw, M4x40	0140-6226-128
12	Lockwasher, M4 external	9213-0540-003
13	Plug, 4-mm (if no N_2O)	1006-3530-000
14*	Cover, pan electronic enclosure	1009-3047-000
15*	Gasket, EMI electronic enclosure (4 required)	1009-5811-000

* The top side of the cover has rounder edges. Apply the EMI gasket to the underside (sharp edges) of the cover.

** Also requires Item 7, EMI gasket, two each.

10.11 Electronic Gas Mixer

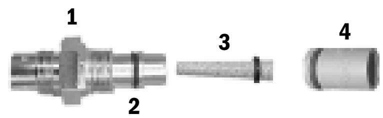
⚠ CAUTION Ensure a clean environment when servicing the gas mixer.

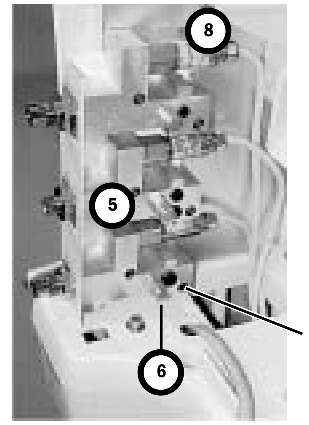


Item	Description	Stock Number
1	Mixer Assembly - complete	1011-8000-000
2	Valve, 2-way NO (includes screws and gasket)	1009-3014-000
3	Valve, 2-way NC (includes screws and gasket)	1009-3013-000
4	Valve, proportional	1011-3560-000
5	O-ring (2 used with each proportional valve)	6027-0000-165
6	Screw, M3x16 (2 used for mounting each valve)	1504-3003-000
7	Lockwasher, M3 external	9213-0530-003
8	Valve, 3-way NC (includes screws and gasket)	1009-3346-000
9	Flex-cable, valve interface	1009-3359-000
10	Outlet check valve, replacement kit (includes o-ring and flapper valve)	1009-8246-000
11	Retainer, flapper valve	1011-3516-000
12	O-ring, retainer	1011-3518-000
13	Elbow, 1/4 inch tube to 1/8 inch NPT	1011-3071-000
14	Cable, TSI interface	1011-3082-000

* Lubricate sparingly with Krytox.

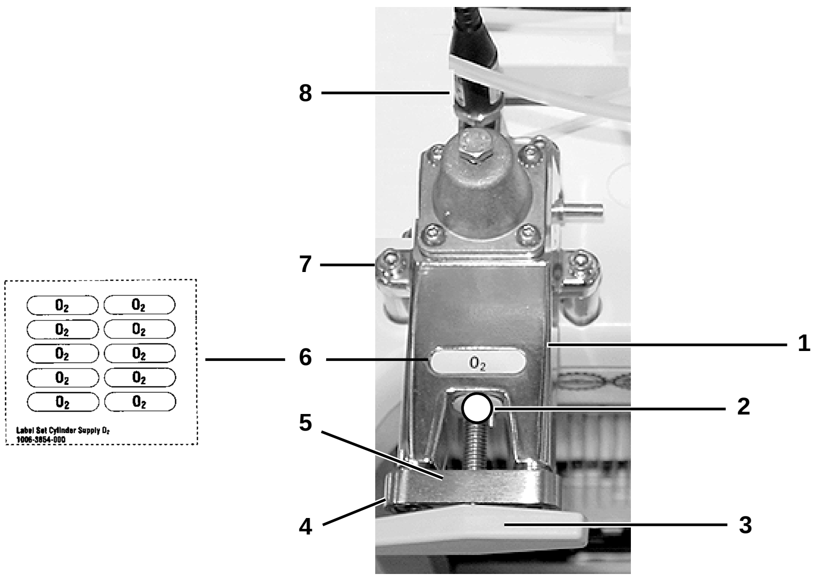
10.12 Pipeline inlet fittings





Item	Description	Stock Number
1	**Pipeline inlet - O_2 fittings**	--------------------
	Body, O_2 DISS	1006-5149-000
	Body, O_2 NIST	1006-5158-000
	Body, O_2 DIN	1006-5161-000
	Body, O_2 G 3/8 BSPP	1006-5170-000
	Pipeline inlet assembly O_2 France	1006-8363-000
	Pipeline inlet assembly O_2 Canada	1006-8360-000
	Pipeline inlet assembly O_2 Australia	1006-8396-000
1	**Pipeline inlet - N20 fittings**	--------------------
	Body, N_2O DISS	1006-5150-000
	Body, N_2O NIST	1006-5159-000
	Body, N_2O DIN	1006-5162-000
	Body, N_2O G 3/8 BSPP	1006-5171-000
	Pipeline inlet assembly N_2O France	1006-8362-000
	Pipeline inlet assembly N_2O Canada	1006-8359-000
	Pipeline inlet assembly N_2O Australia	1006-8397-000
1	**Pipeline inlet Air fitting**	--------------------
	Body, Air DISS	1006-5151-000
	Body, Air NIST	1006-5160-000
	Body, Air DIN	1006-5163-000
	Body, Air G 3/8 BSPP	1006-5172-000
	Pipeline inlet assembly Air France (service kit)	1006-8361-000
	Pipeline inlet assembly Air Canada (service kit)	1006-8358-000
	Pipeline inlet assembly Air Australia (service kit)	1006-8398-000
2	O-ring, bore seal	---------------------
	O_2 and N_2O	0210-0479-300
	Air	0210-0539-300
3	Sintered metal filter with o-ring	1006-8351-000
4	Pipeline check valve with o-ring	1505-3273-000
5	Gas Inlet Manifold (replacement) O_2	1009-8066-000
	N_2O	1009-8067-000
	Air	1009-8068-000
6	Relief valve, 689/758 kPa (100/110 psi)	1011-3049-000
7	Screw, M4x20	0144-2124-218
	Lockwasher, M4	9213-0540-003
8	Transducer, pipeline pressure (includes cable)	1011-3000-000

10.13 Cylinder Gas Supplies

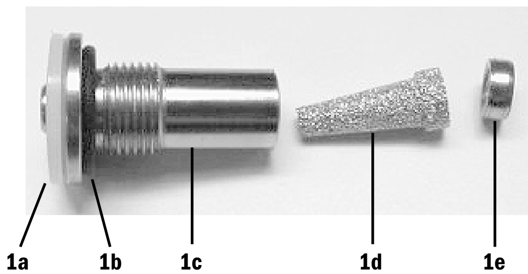


Item	Description	Pin Index	DIN	DIN (Large Cylinder)
1	Gas supply O_2	1006-3201-000	1006-3207-000	1006-3880-000
1	Gas supply N_2O	1006-3225-000	1006-3208-000	1006-3881-000
1	Gas supply Air	1006-3203-000	1006-3209-000	--------------------

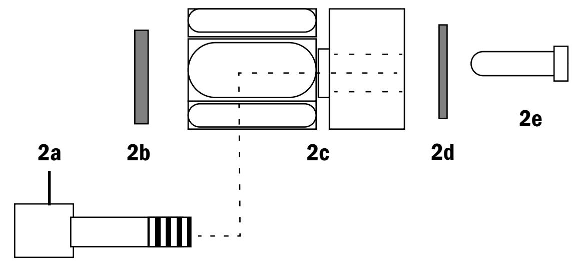
Item	Description	Stock Number
2	Cylinder inlets (Pin Index or DIN for external cylinder)	Refer to section 10.13.1
3	Tee handle beige	0219-3372-600
4	Spacer, gas block (2) Screw, M8 x 25 long socket head cap (2)	1001-4077-000 9211-0680-253
5	Clamp, yoke	1001-4076-000
6	Label Set, cylinder supply, O_2 Label Set, cylinder supply, N_2O Label Set, cylinder supply, Air	1006-3854-000 1006-3855-000 1006-3856-000
7	Screw M6x25 socket head cap/ 3 per supply Lockwasher (for above screw) Internal M6	9211-0660-254 0144-1118-130
8	Transducer, cylinder pressure (includes cable) Refer to Section 9.13 for replacement procedure.	1011-3001-000

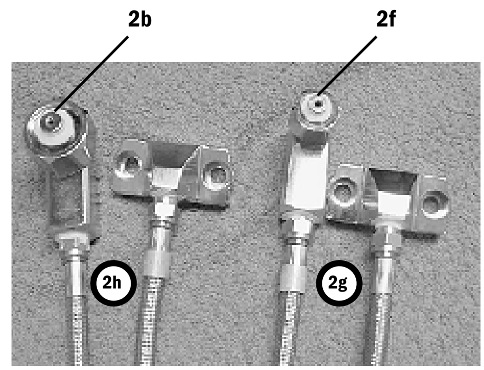
10.13.1 Cylinder inlet fittings

1 Pin Index



2 DIN (external cylinder)

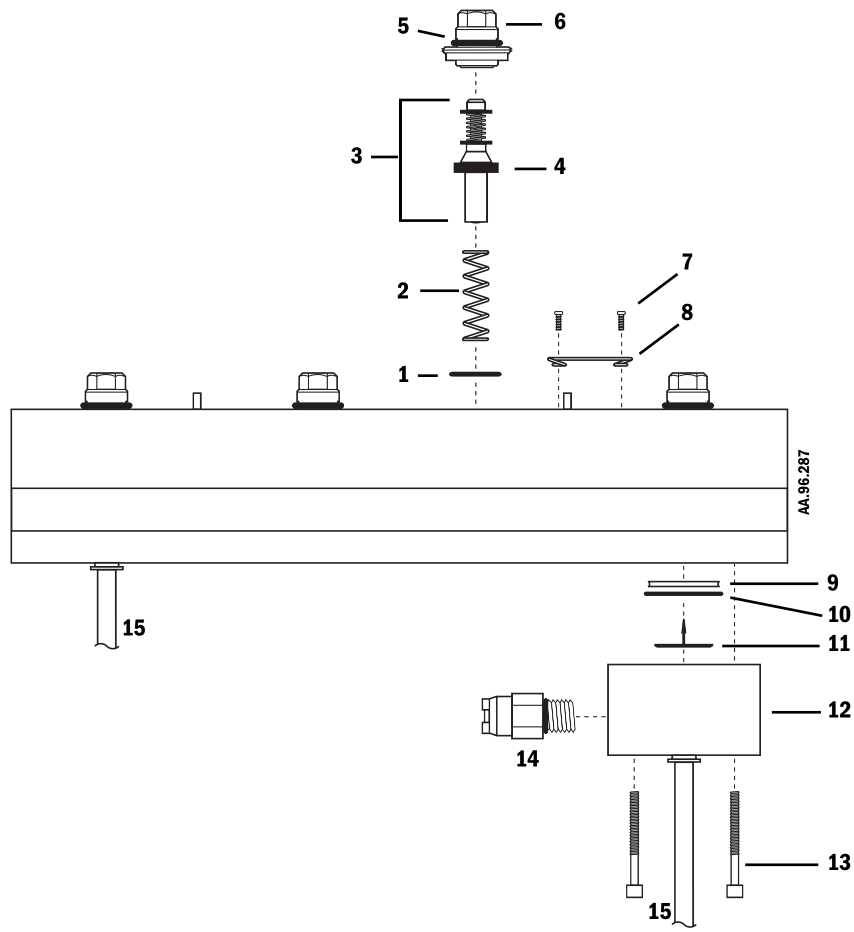




Item		Description	Stock Number
1		**Cylinder inlets (Pin Index)**	--------------------
	1a	Gasket	0210-5022-300
	1b*	O-ring	9221-3013-116
	1c	Adapter, inlet	1001-4075-000
	1d	Filter, sintered bronze	9914-6380-000
	1e	Retaining ring, filter	1001-5954-000
2		**Cylinder inlets (DIN)**	--------------------
	2a	Screw, M8x16	0144-2140-242
	2b	Sealing ring (DIN)	1009-3356-000
	2c	DIN Adapter (O_2)	1006-4000-000
		DIN Adapter (N_2O)	1006-4001-000
		DIN Adapter (Air)	1006-4002-000
	2d	O-ring, 0.687 ID, 0.812 OD	0210-0544-300
	2e	Filter, sintered bronze	9914-6380-000
	2f	Sealing ring, N_2O DIN Conn 11	1202-3641-000
	2g	Adapter, large cylinder N_2O	1006-4028-000
	2h	Adapter, large cylinder O_2	1006-4027-000

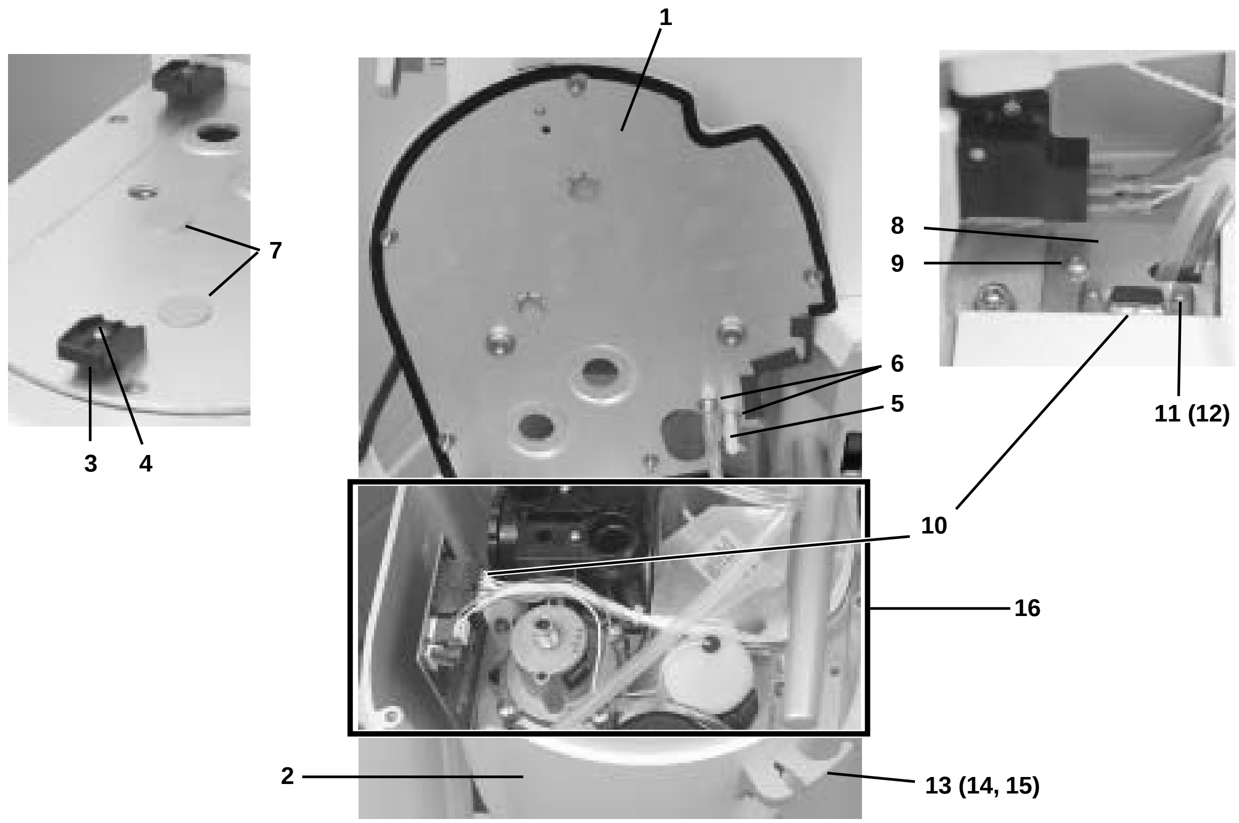
* Lubricate sparingly with Krytox

10.14 Vaporizer manifold



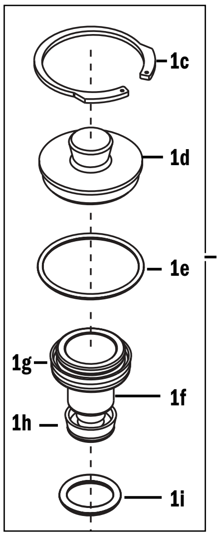
Item	Description	Stock Number
	Manifold assembly, complete, two position	1006-8355-000
	Manifold assembly, complete, one position	1009-8065-000
1	O-ring, 0.687 inch ID 0.812 inch OD	0210-0544-300
2	Spring, compression	1006-3736-000
3	Valve kit, includes seal	1006-8373-000
4	Seal	1006-3690-000
5	O-ring, 14.3 mm ID	1102-3043-000
	(Package of 6 o-rings)	1102-3016-000
6	Nipple, vaporizer port (New Style)	1006-4215-000
7	Screw, M2.5 - 0.45x6 PAN, Pozidriv, SST	1006-3037-000
8	Spring, Dzus	1102-3056-000
9	Seat, check valve	1006-1352-000
10	O-ring 27.1 OD 21.89 mm ID	1006-3866-000
11	Flapper	0211-1451-100
12	Housing	1009-8477-000
13	Screw, M4 x 30, cap head	9211-0640-304
14	Valve, relief, 5.5 psi, 7/16-20 THD	1006-4128-000
15	Flexible tubing, 1/4 inch, mixed gas	1001-3064-000

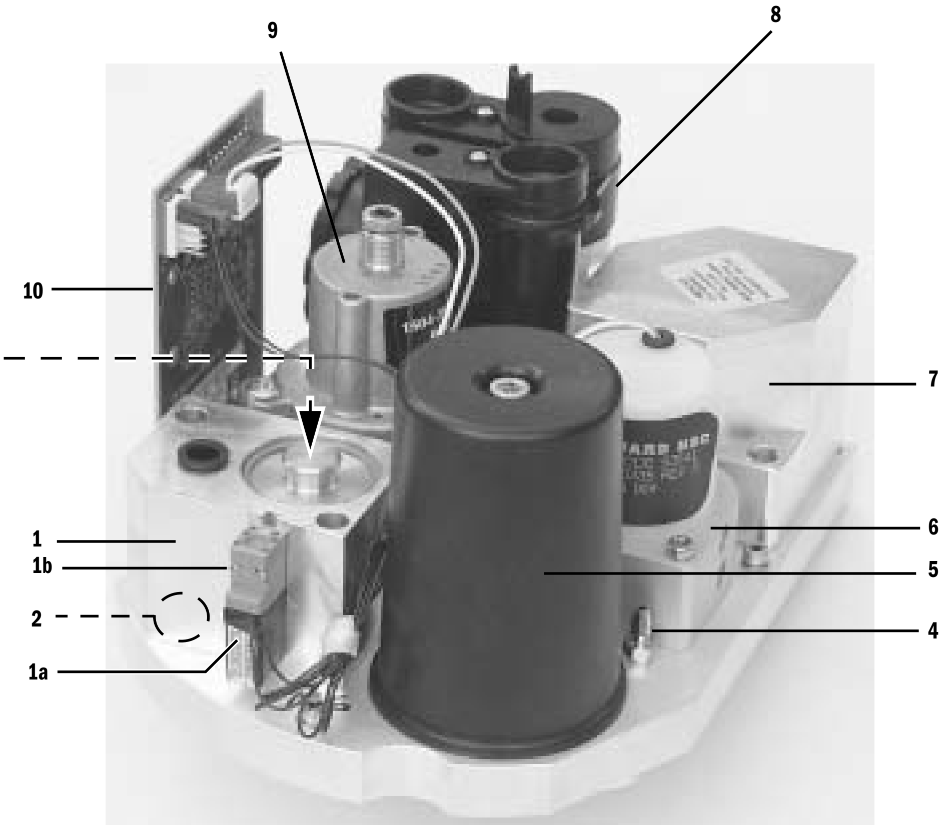
10.15 Vent Engine Housing

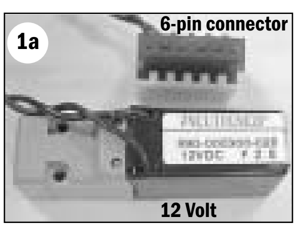


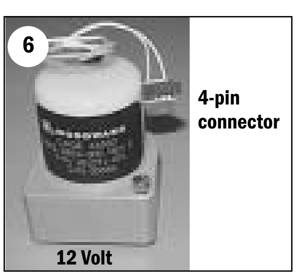
Item	Description	Stock Number	Qty
1	Vent Engine Cover Plate Assy	1407-7009-000	
2	CASTING VENT ENG HOUSING	1407-3301-000	
3	TAB GUIDE BELLOWS BASE	1407-3313-000	(2)
4	SCR M3X16 POSI DR PAN HD A4 SST	1504-3003-000	(2)
5	Cap, Plug	1406-3524-000	
6	FITTING PNL MOUNT 3.18 HOSE BARB UNION	1504-3014-000	(2)
7	PLUG HOLE 15.9 DIA NYLON MICRO PLASTICS	1006-1473-000	
8	PLATE CONN VENT	1407-3321-000	
9	SCR M4X8 POZI-DR DIN84 PAN SERRATED	1006-3178-000	(3)
10	Harness, Vent Engine Board to Connector Plate	1009-5545-000	
11	BLOCK LATCHING DSUB CONN	1504-3617-000	(2)
12	SCR 4-40 X 3/8 SKT BCG HD CAP	0144-2117-206	(2)
13	CLIP-SUCTION BAG HOSE	1407-3327-000	
14	SCR M5 X 16 PAN PH HD SST	9211-8350-163	(2)
15	Lockwasher	0144-1118-220	(2)
16	Vent Engine	Refer to section 10.16	

10.16 Vent Engine



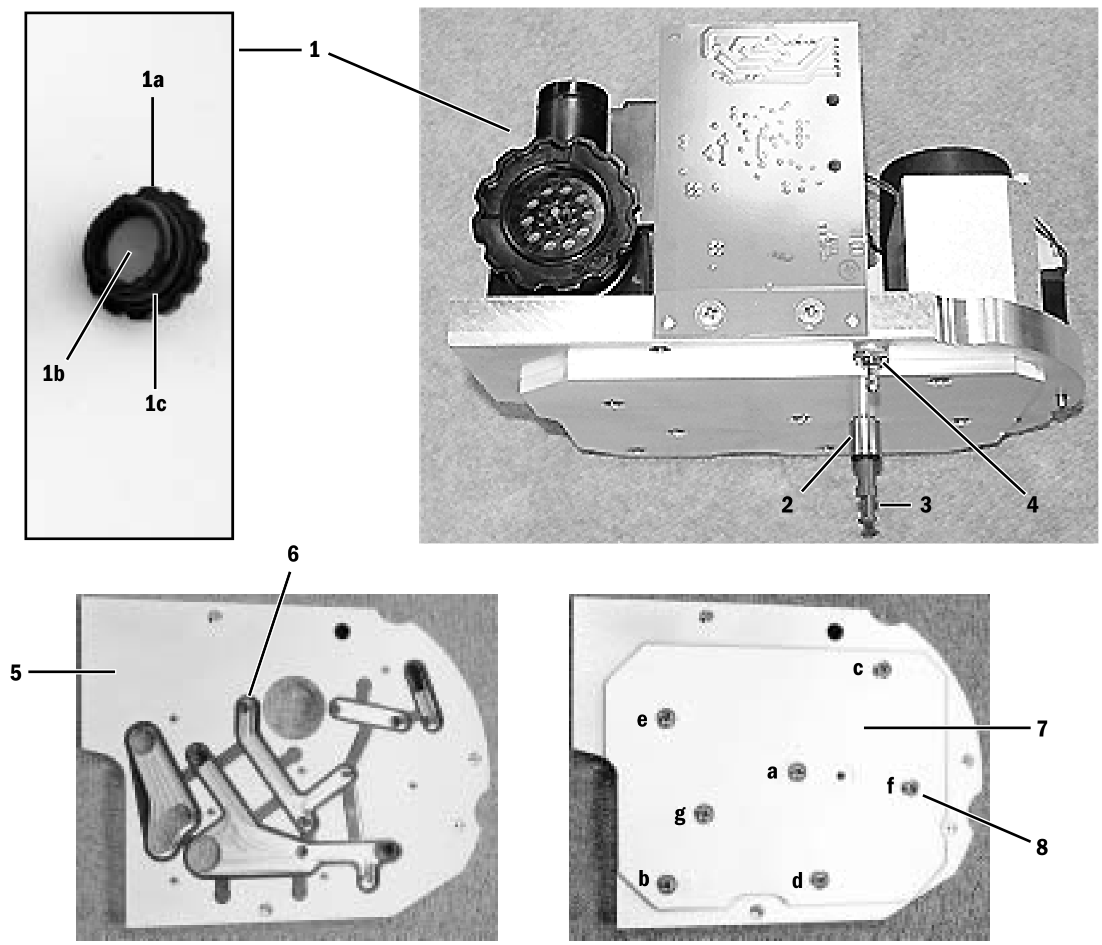






Item		Description	Stock Number
		Vent Engine Assembly, Service (Avance/Aisys)	1009-8216-000
1		Gas Inlet Valve (GIV) components	Refer to section 9.10.3
	1a	Solenoid, 3-way NO (12 Volt)	1503-3853-000
	1b	Screw, m1.6x14	1006-4730-000
	1c	Retaining ring, 34.9 mm	1500-3158-000
	1d	Cap, inlet valve	1503-5006-000
	1e	O-ring, upper Viton	9221-3032-116
	1f	Shuttle, inlet valve	1503-5018-000
	1g	U-cup, upper EDPM (fits on shuttle valve)	1503-3090-000
	1h	U-cup, lower Viton (fits on shuttle valve)	1503-3089-000
	1i	O-ring, lower Viton	1503-3108-000
2		Filter (under GIV), 2-micron (install course side DOWN)	1504-3708-000
4		Fitting, manifold pressure	1500-3116-000
5		Reservoir, pneumatic engine	1504-3704-000
		O-ring, base, 56.87 ID x 60.43 OD	1504-3614-000
		O-ring, screw head, 0.219 ID x 0.344 OD	0210-0686-300
		Screw, M6x90	1504-3004-000
6		Flow control valve (12 Volt)	1503-3854-000
		O-ring under flow control valve (2 each)	1503-3056-000
7		Drive gas check valve	1503-3006-000
		O-ring under drive gas check	1503-3213-000
8		Interface Manifold	Refer to section 10.16.1
9		Regulator, 172 kPa BCG	1504-3623-000
10		Vent Engine Connector board (not part of assembly)	1011-3165-000

10.16.1 Vent Engine - under side



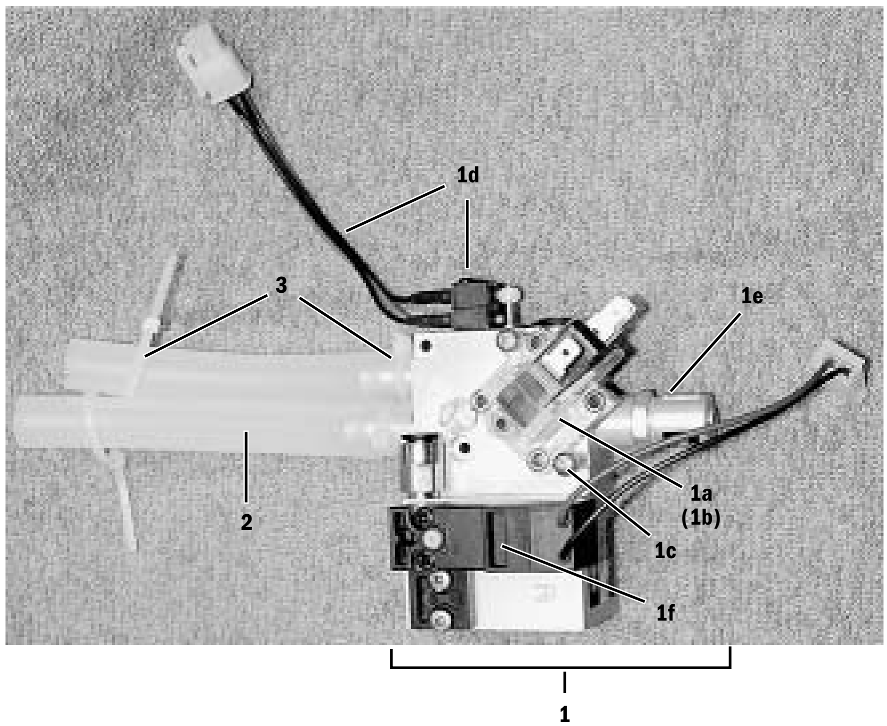
Item	Description	Stock Number
1	Interface Manifold, pneumatic engine (with free breathing valve and mechanical overpressure valve)	1504-8505-000
	O-ring, 12.42 ID x 15.98 OD (2)	1006-3615-000
1a	Seat, free breathing valve	1503-3204-000
1b*	Valve, flapper	0211-1454-100
1c	O-ring	1503-3208-000
2	Fitting, 6.35-mm (1/4-inch)	1504-3621-000
3	Plug, 6.35-mm (1/4-inch)	1503-3245-000
4	Fitting, barbed	1504-3014-000
5	Manifold	1503-3843-000
6**	Gasket, manifold	1503-3845-000
7	Plate, manifold	1503-3844-000
8***	Screw, M4x8 Pozidriv PAN	1006-3178-000

* If necessary, clean with alcohol before installing new; trim off flush with outside surface of seat (refer to removed flapper).

** Install gasket into manifold. Check to see that it is properly positioned.

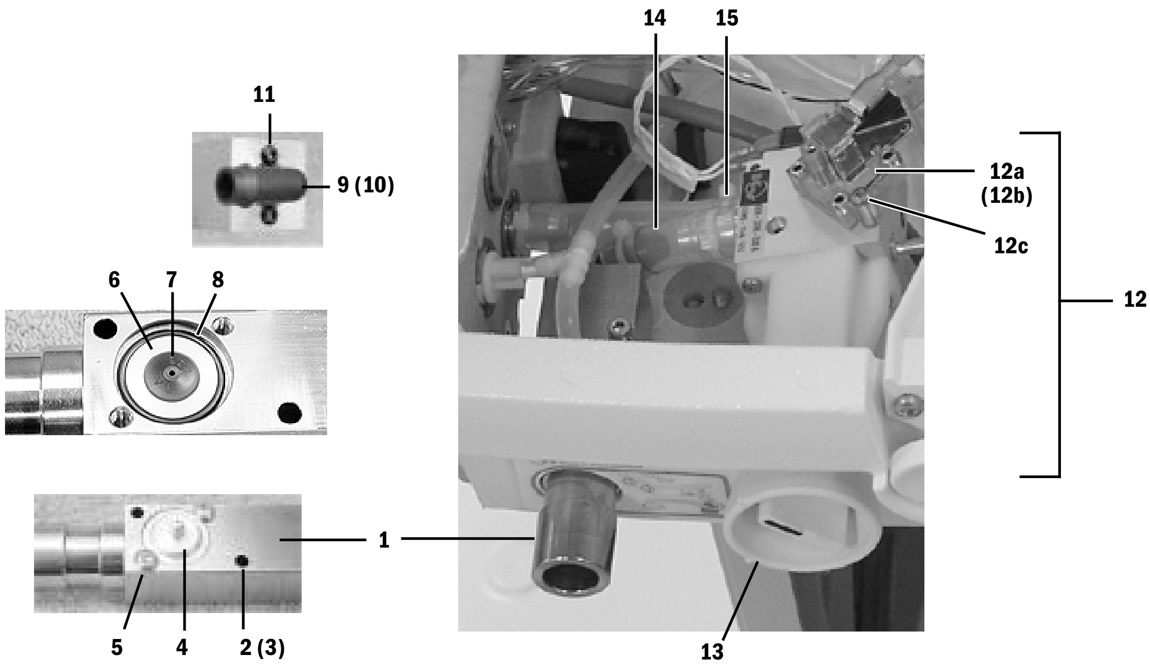
*** Carefully install plate onto manifold making sure not to disturb the gasket.
First, start all screws. Then, torque to 1.7 N-m (15 lb-in) using sequence shown.

10.17 ABS to machine Interface Components (SCGO)



Item	Description	Stock Number
1	SCGO Selector Module, complete	1009-3098-000
1a	Flush pressure switch (includes o-ring)	1006-3972-000
1b	O-ring	1006-3213-000
1c	Screws, M3x20	0144-2124-201
1d	Switch, mode (CGO/SCGO), kit	1009-3282-000
1e	Valve, relief 150 cmH2O	1009-3052-000
1f	Solenoid kit CGO	1009-3279-000
2	Tubing, silicone (110 mm, 100 mm)	1009-3164-000
3	Tie wrap	0203-5915-300

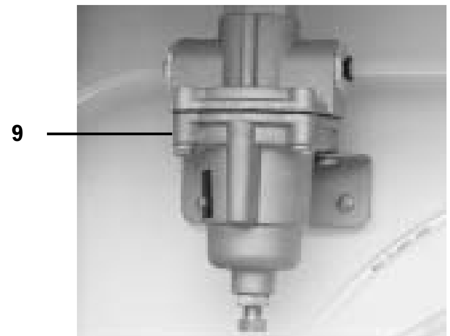
10.18 ABS to machine Interface Components (ACGO)

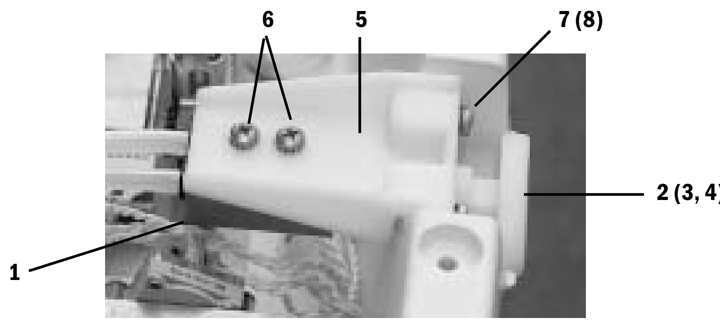


Item	Description	Stock Number
	Service Kit to covert SCGO Avance machine to ACGO	1009-8249-000
1	Port, ACGO body	1009-3096-000
2	Screw, M4x30	9211-0640-304
3	Lockwasher, M4	9213-0540-003
4	Cap, ACGO check valve	1009-3095-000
5	Screw, M4x8	9211-1040-069
6	Disk, ACGO check valve	1009-3062-000
7	Flapper, ACGO check valve	1009-3097-000
8*	O-ring	0210-0543-300
9	Fitting, elbow barbed	1009-3160-000
10*	O-ring	0210-0691-300
11	Screw, M3x6	9211-1030-055
12	ACGO Selector Switch, complete (without guard - item 13)	1009-3099-000
12a	Flush pressure switch	1006-3972-000
12b	O-ring	1006-3213-000
12c	Screws, M3x20	0144-2124-201
13	Guard	1009-3140-000
14	Tubing, silicone	1009-3164-000
15	Tie wrap	0203-5915-300

* Lubricate sparingly with Krytox.

10.19 Flush Regulator and Flush Valve

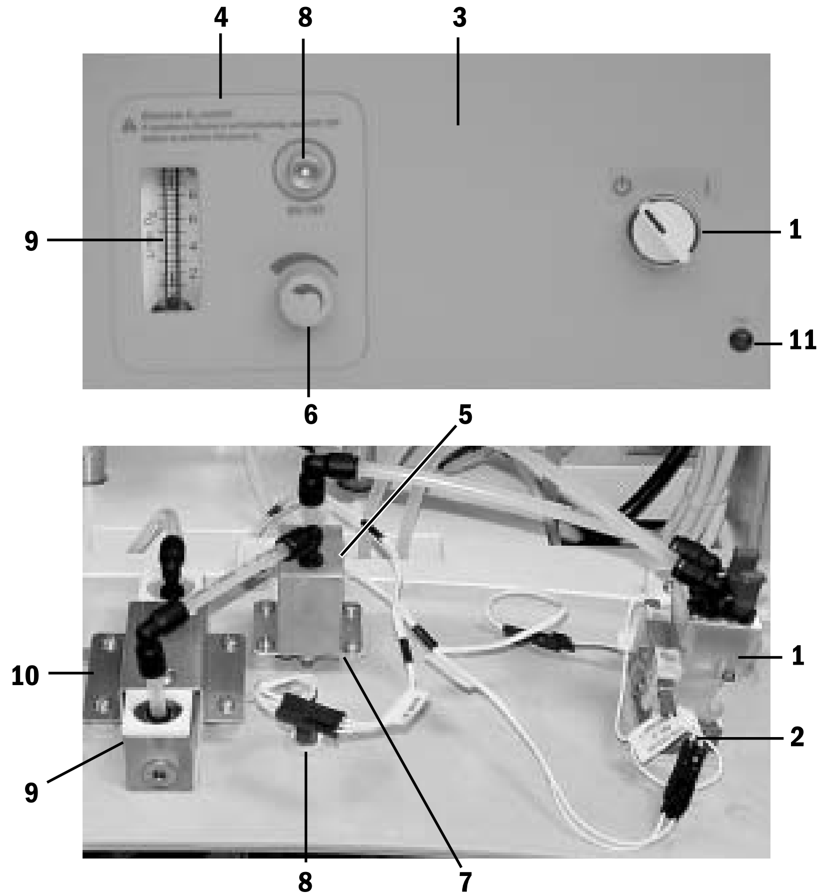




Item	Description	Stock Number
1	Flush valve, without button	1006-8357-000
2	Flush Button with rod	1011-3354-000
3	Spring	1006-3186-000
4	E-ring	0203-5225-300
5	Bracket	1011-3355-000
6	Screw, M4x8	1006-3178-000
7	Screw, M4x12	0140-6226-111
8	Lockwasher, M4	9213-0540-003
9	Regulator, O_2 Flush	1011-3168-000

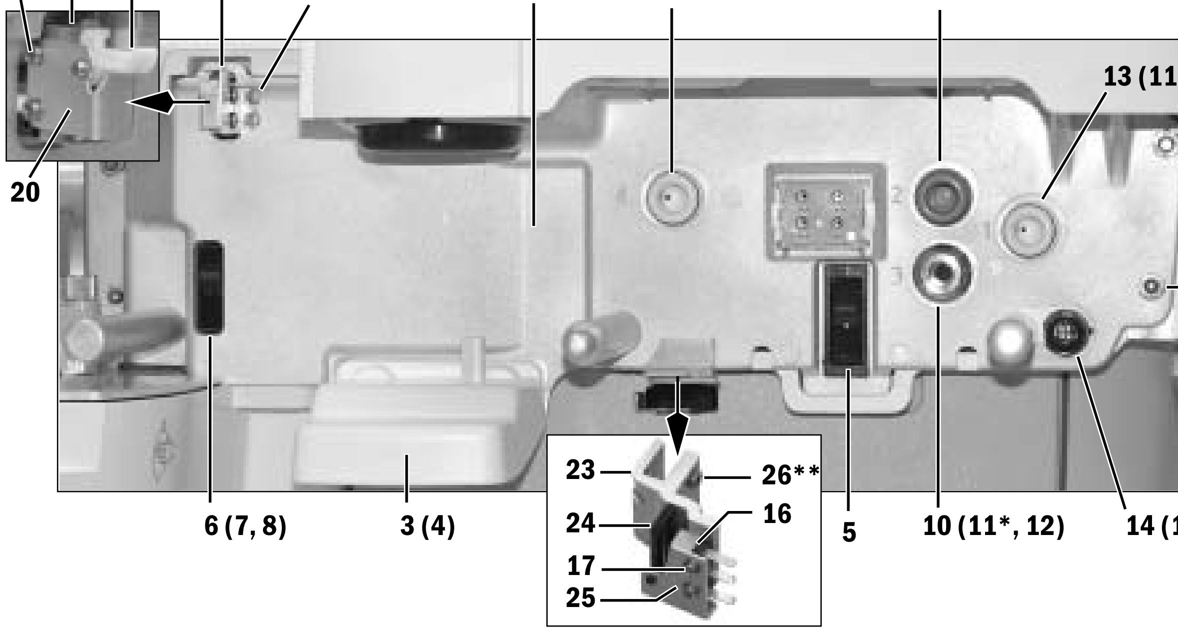
10.20 Front panel, Alt O2, and system switch

Table 1:	
Language	**Alt O_2 Label**
Chinese	1009-3332-000
Czech	1009-3322-000
Danish	1009-3331-000
Dutch	1009-3317-000
English	1009-3315-000
Finnish	1009-3321-000
French	1009-3316-000
German	1009-3314-000
Greek	1009-3326-000
Hungarian	1009-3327-000
Italian	1009-3318-000
Japanese	1009-3328-000
Norwegian	1009-3324-000
Polish	1009-3323-000
Portuguese	1009-3320-000
Russian	1009-3330-000
Spanish	1009-3319-000
Turkish	1009-3325-000



Item	Description	Stock Number
1	Switch, system On/Standby	1006-8452-000
2	Harness, On/Standby system switch	1009-5542-000
3	Panel	1009-3019-000
4	Label, Alt O_2	See Table 1
5	Needle Valve assembly, flow control	1011-3429-000
6	Knob (set screw not included)	1011-3472-000
	Set screw	9211-0830-053
7	Bracket	1009-3127-000
	Screw, M4x8 (bracket to needle valve - 2 each)	0144-2436-108
	Screw, M4x10 (assembly to front panel - 4 each)	1009-5534-000
8	Switch, Alt O_2 (includes harness)	1009-5517-000
9	Flowmeter, Alt O_2	1011-3428-000
10	Bracket, flowmeter	1009-3126-000
	Screw, 10-32x3/8 (bracket to flowmeter - 2 each)	0140-6631-107
	Screw, M4x10 (assembly to front panel - 4 each)	1009-5534-000
11	LED assembly, mains green	1009-5514-000

10.21 Breathing system interface



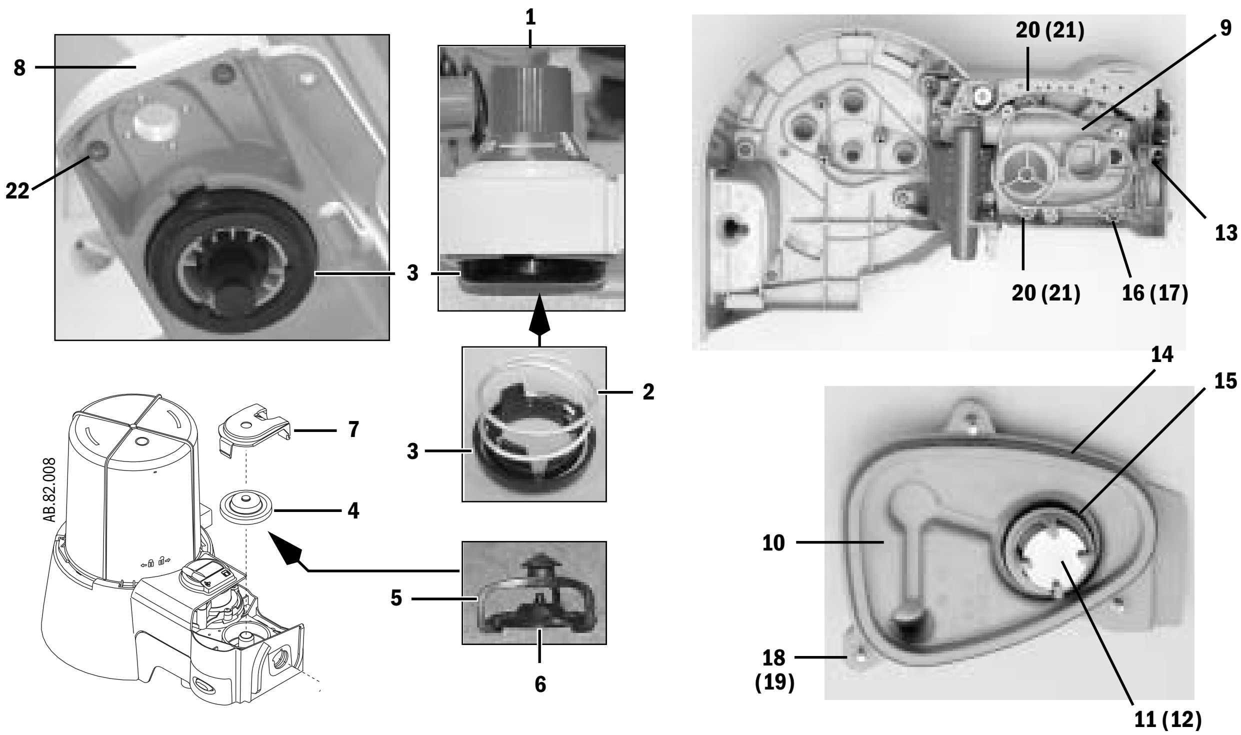
Note: SCGO only applies to Avance and Aisys machines.

Item	Description	Stock Number	Qty
1	Assembly, main support casting	1407-7010-000	
2	Bolt, M6x16 flange	1009-3125-000	(5)
3	Handle, grip	1407-3317-000	
4	Screw, M6X16 Sems	0144-2436-109	(2)
5	Latch, push to close	1407-3309-000	
6	Latch, push to close w/microswitch	1407-3310-000	
7	Screw, SKT HD CAP M3x8 SST	1006-3865-000	(2)
8	Washer, lock external M3	9213-0530-003	(2)
9	Port, plug circuit (ACGO)	1407-3333-000	
10	Port, fresh gas (SCGO)	1407-3314-000	
11*	Seal, U-Cup 12.7 ID BCG 19.05 OD EPR	1407-3320-000	(4)
12	Ring, retaining 15.88 SHAFT DIA TYPE E SST	1406-3446-000	(4)
13	Port, sample gas	1407-3318-000	(2)
14	Connector, bulkhead O2 Cell, with harness	1009-5586-000	
15	Ring, retaining 9.53 SHAFT DIA TYPE E SST	1406-3277-000	
16	Switch, subminiature w/QDISC terminals	1406-3296-000	(2)
17	Screw, M2.5 x10	1009-3153-000	(4)
18	Bracket, BTV switch	1407-3319-000	
19	Lever, BTV switch	1407-3325-000	
20	Bracket, cap BTV	1407-3324-000	
21	Screw, SKT HD CAP M3x8 SST	1006-3865-000	(2)
22	Washer, lock external M3	9213-0530-003	(2)
23	Bracket, bypass switch	1407-3139-000	
24	Paddle, switch actuator	1407-3141-000	
25	Bracket, paddle hinge	1407-3140-000	
26**	Screw, M6x6 set cup	1007-3329-000	(2)

* Lubricate sparingly with Krytox.
** Apply Loctite 242.

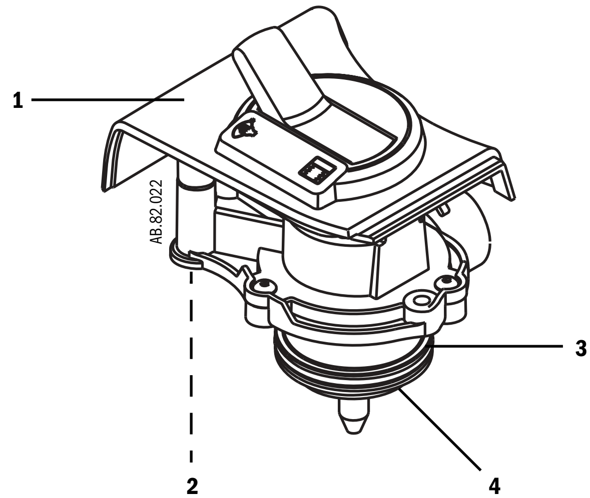
10.22 Breathing System

10.22.1 APL Valve



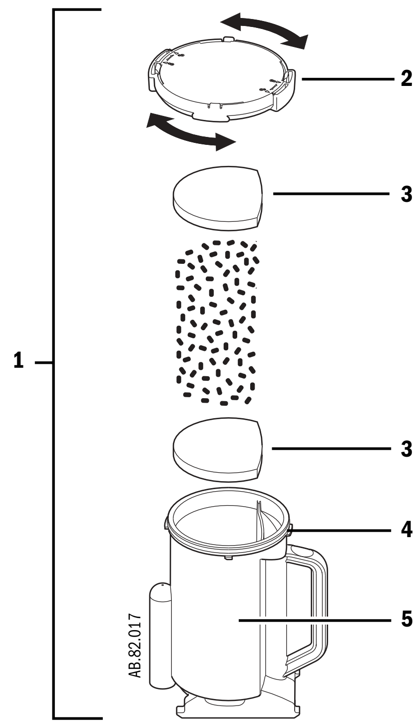
Item	Description	Stock Number	QTY
1	APL Valve Assy (includes items 2 through 6)	1009-8200-000	
2	SPRING CPRSN 53.14 OD 36.8 L 1.48 N/MM	1406-3328-000	
3	RETAINER SPRING APL	1407-3404-000	
4	DIAPHRAGM APL	1406-3331-000	
5	CAGE APL	1406-3333-000	
6	POPPET APL VALVE	1406-3332-000	
7	RAMP APL	1407-3400-000	
8	COVER APL	1407-3405-000	
9	MANIFOLD APL/BTV	1407-3401-000	
10	Cover, Manifold APL/BTV (with 22-mm male bag port)	1407-3402-000	
	Cover, Manifold APL/BTV (with Australian bag port - 22 mm female)	1407-3412-000	
11	WEIGHT DEAD 14CM H2O BCG ABS NEG RELIEF	1407-3406-000	
12	SEAL ABS NEG RELIEF VLV	1407-3407-000	
13	O-RING 22 ID 30 OD 4 W SI 40 DURO	1407-3104-000	
14	O-RING 88.49 ID 95.55 OD 3.53 W SILICONE 50 DURO	1407-3403-000	
15	O-RING 1.049ID 1.255OD .103W EPDM NO 121	1407-3408-000	
16	SCR M4X16 BT SKT HD SST TYPE 316	0140-6226-115	(2)
17	Lockwasher, M4 external	9213-0540-003	(2)
18	SCR THUMB M4 SHLDR 7.5 X 7	1407-3410-000	(3)
19	RING RETAINING 3.96 SFT DIA CRESCENT SST	1407-3411-000	(3)
20	SCR M4 X 40 FL HD SST PH	0140-6226-122	(2)
21	O-RING 2.9 ID 6.46 OD 1.78 W EP 70 DURO	1407-3409-000	(2)
22	SCR SEMS M4X8 BT SKT HD W/EXT L/W SST 316	0144-2436-108	(3)

10.22.2 Bag/Vent Switch



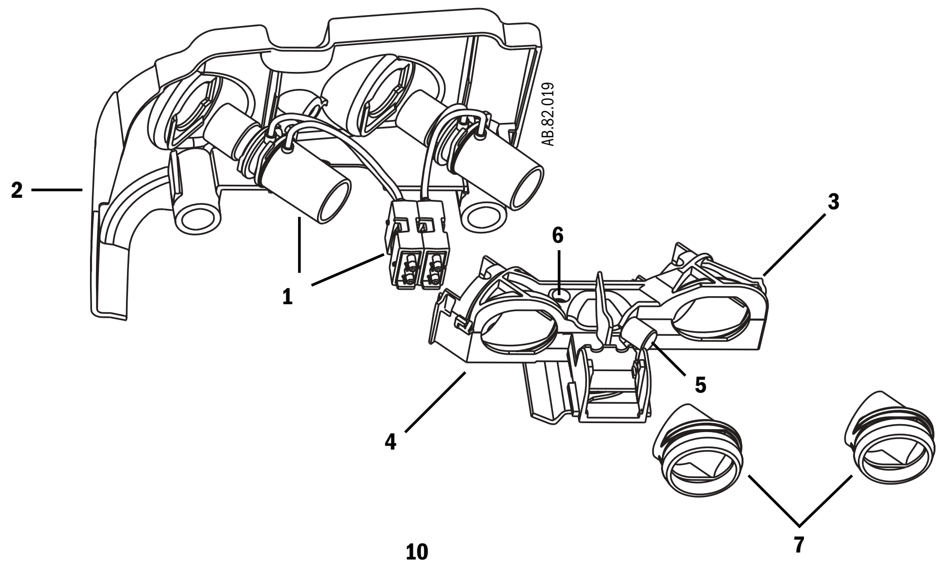
Item	Description	Stock Number	QTY
	BTV Switch Cartridge	1407-7003-000	
1	COVER BTV	1407-3500-000	
2	SCR SEMS M4X8 BT SKT HD W/EXT L/W SST 316	0144-2436-108	(2)
3	O-RING 44.02 ID 51.1 OD 3.53 W SI 70 DURO	1407-3507-000	
4	SEAL, BTV	1407-3506-000	

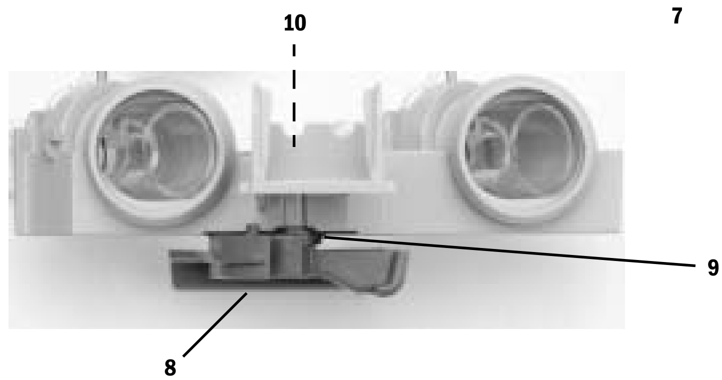
10.22.3 Absorber canister



Item	Description	Stock Number	Qty
1	Multi-Absorber canister, reusable (does not include absorbent)	1407-7004-000	
2	Cover assembly, CO_2 canister	1009-8240-000	
3	Foam, CO_2 canister (pack of 40)	1407-3201-000	
4	O-ring	1407-3204-000	
5	Canister, CO_2	1407-3200-000	
---	Multi-Absorber canister, disposable (white to violet; pack of 6)	8003138	
---	Multi-Absorber canister, disposable (pink to white; pack of 6)	8003963	

10.22.4 Flow Sensor Module

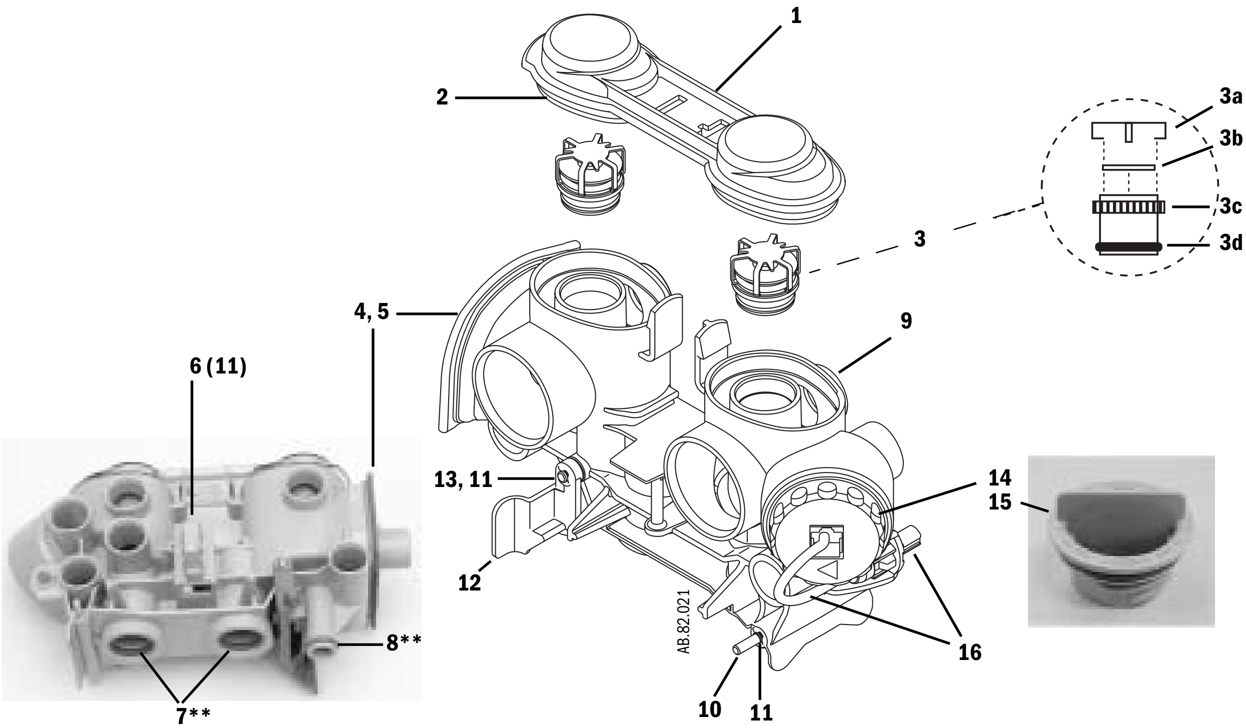




Item	Description	Stock Number	Qty
	Flow Sensor Module (*)	1407-7001-000	
1*	Flow Sensor (plastic - moisture resistant)	1503-3858-000	
	Flow Sensor (metal - autoclavable)	1503-3244-000	
	Flow Port Adapter	1503-3849-000	
2	Cover, Flow Sensor (Avance and Aespire machines)	1407-3000-000	
	Cover, Flow Sensor (Aisys machines)	1011-3283-000	
3	HOLDER FLOW SNSR UPPER	1407-3002-000	
4	HOLDER FLOW SNSR LOWER	1407-3003-000	
5	SCR THUMB M6X43 SST	1406-3304-000	
6	SCR M4 .07 X 10 SKT CAP BUTTON HEAD SST	0144-2117-718	(2)
7	CUFF FLOW SNSR	1407-3004-000	(2)
8	LATCH FLOW SNSR	1407-3001-000	
9	SPR TORSION FLOW SNSR LATCH	1407-3005-000	
10	RING TRUARC .188 SHAFT E-RING SST	0203-5225-300	

* The flow sensors are not included in the flow sensor module.

10.22.5 Breathing Circuit Module

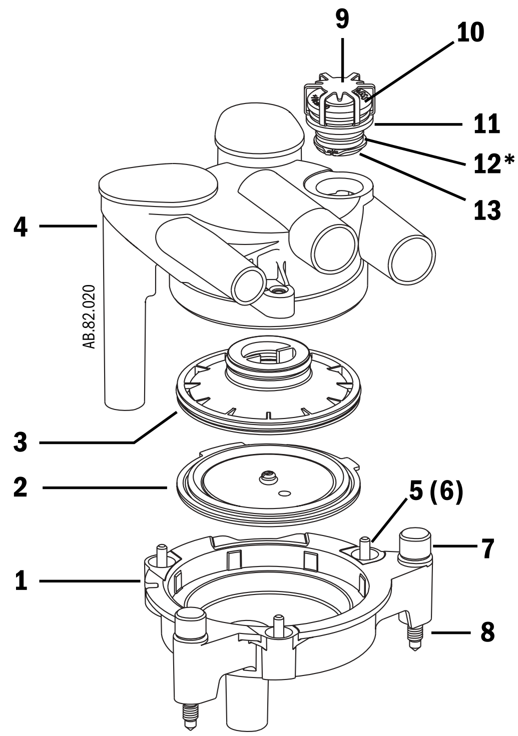


Item	Description	Stock Number	Qty
	Breathing Circuit Module *	1407-7002-000	
1	LENS CIRCUIT CHK VALVES	1407-3101-000	
2	O-RING 44.02 ID 51.1 OD 3.53 W SI 70 DURO	1407-3507-000	(2)
3	Check Valve Assembly	1406-8219-000	(2)
3a	RETAINER DISK 26.97D 12.7H 0.76T	1400-3017-000	(2)
3b	DISC CHK V RVSBL 1.025D	0210-5297-100	(2)
3c	SEAT UNIDIRECTIONAL V B/S	1406-3396-000	(2)
3d	O-RING 20.35 ID 23.90 OD 1.78W	1406-3397-000	(2)
4	PLATE CIRCUIT FLANGE	1407-3110-000	
5	SCR SEMS M4X8 BT SKT HD W/EXT L/W SST 316	0144-2436-108	(6)
6	HOOK LATCH	1407-3604-000	
7**	O-RING 22 ID 30 OD 4 W SI 40 DURO	1407-3104-000	(2)
8**	O-RING 12.37 ID 17.6 OD	1006-3968-000	
9	MANIFOLD CIRCUIT	1407-3100-000	
10	PIN CANISTER PIVOT	1407-3109-000	
11	RING TRUARC .188 SHAFT NO 5133-18H E-RING SST	0203-5225-300	(5)
12	LEVER CANISTER LATCH	1407-3102-000	
13	PIN CANISTER LEVER	1407-3108-000	
14*	O_2 Cell (includes o-ring)	6050-0004-110	
	O-ring, cell	1406-3466-000	
15*	Plug with o-ring (for units without circuit O_2 sensing)	1503-3857-000	
	O-ring, plug	1406-3466-000	
16*	Cable, O_2 Cell	1009-5570-000	

* The O_2 cell (or plug) and the cell cable are not included in the breathing circuit module.

** Lubricate sparingly with Krytox.

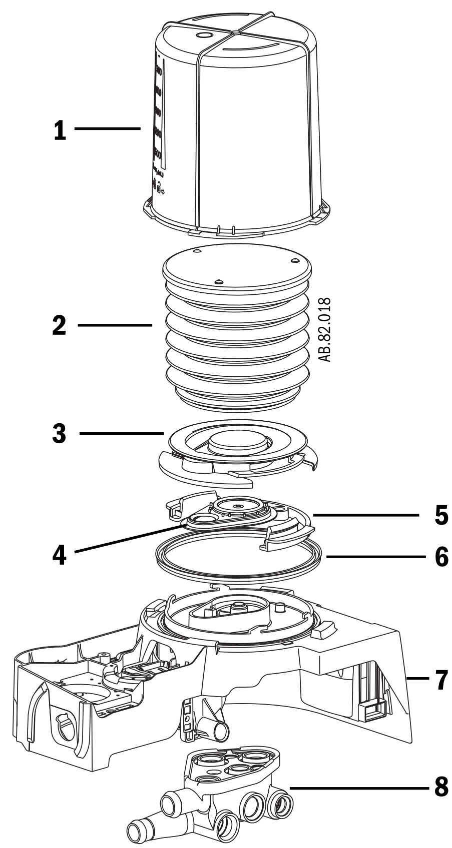
10.22.6 Exhalation valve



Item	Description	Stock Number	Qty
	Exhalation Valve assembly	1407-7005-000	
1	Base, exhalation valve	1407-3701-000	
2	Diaphragm assembly	1503-8121-000	
3	Seat, exhalation valve	1407-3704-000	
4	Cover, exhalation valve	1407-3700-000	
5	Screw, M4x16 PH PAN HD	9211-0440-163	(3)
6	O-ring, 2.9 ID 6.46 OD 1.78 W EP 70 DURO	1407-3409-000	(3)
7	Thumbscrew, M6x43 10mm head	1406-3306-000	(2)
8	O-ring, 4.47 ID x 8.03 OD 1.78 W EPR 70 DURO	1407-3703-000	(2)
9	Retainer, disk 26.97D 12.7H 0.76T SST flutter	1400-3017-000	
10	Weight, dead 10 cm H2O	1406-3572-000	
11	Seat	1406-3571-000	
12*	O-ring, OD19.16 ID15.6 EPDM DURO 70 -016	1006-3616-000	
13	Ring, retaining 19.05 SHAFT DIA	1406-3577-000	

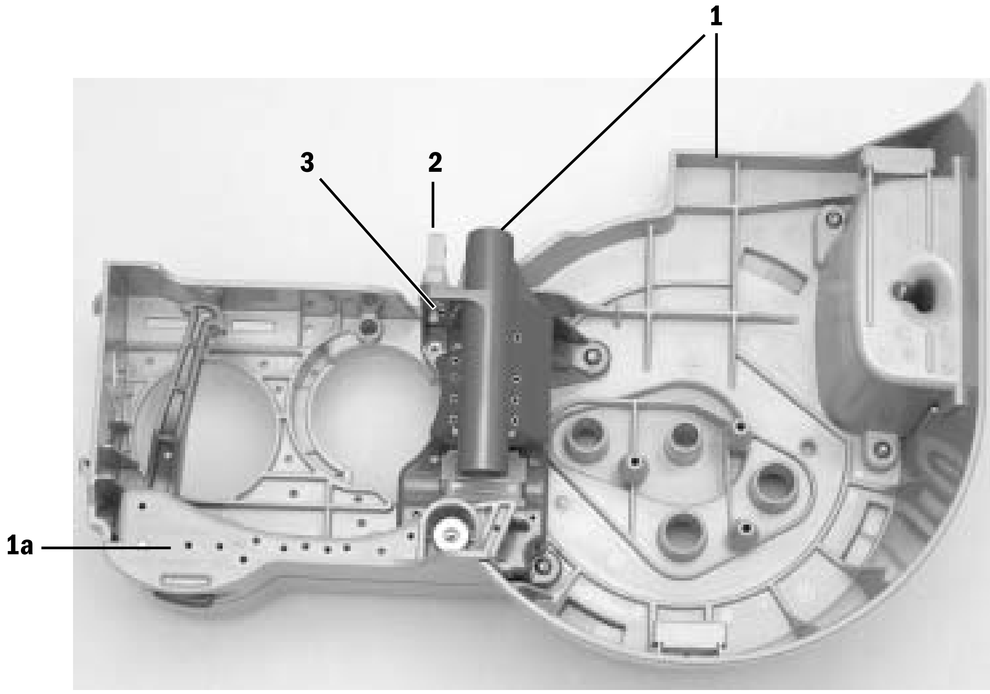
* Lubricate sparingly with Krytox.

10.22.7 Bellows



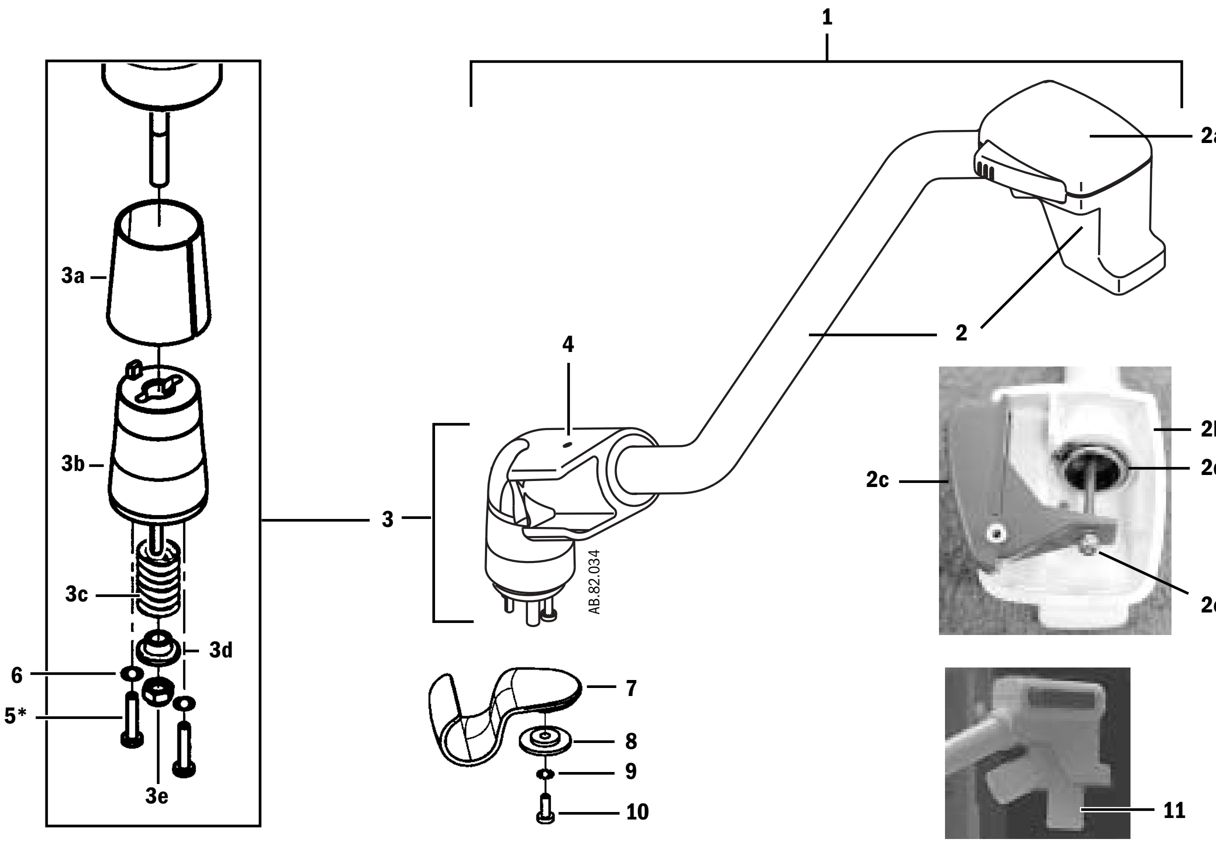
Item	Description	Stock Number
1	Bellows housing	1500-3117-000
2	Bellows	1500-3378-000
3	Rim	1500-3351-000
4	Pressure relief valve assy	1500-3377-000
5	Latch, base	1500-3352-000
6	Seal, base	1500-3359-000
7	Base, bellows	Refer to section 10.22.8
8	Manifold, bellows base	1407-3702-000

10.22.8 Bellow base



Item		Description	Stock Number
1		Bellows Base Assy	1407-7006-000
	1a	Latch Assy	1407-7007-000
2		HOOK LATCH	1407-3604-000
3		E-Ring	0203-5225-300

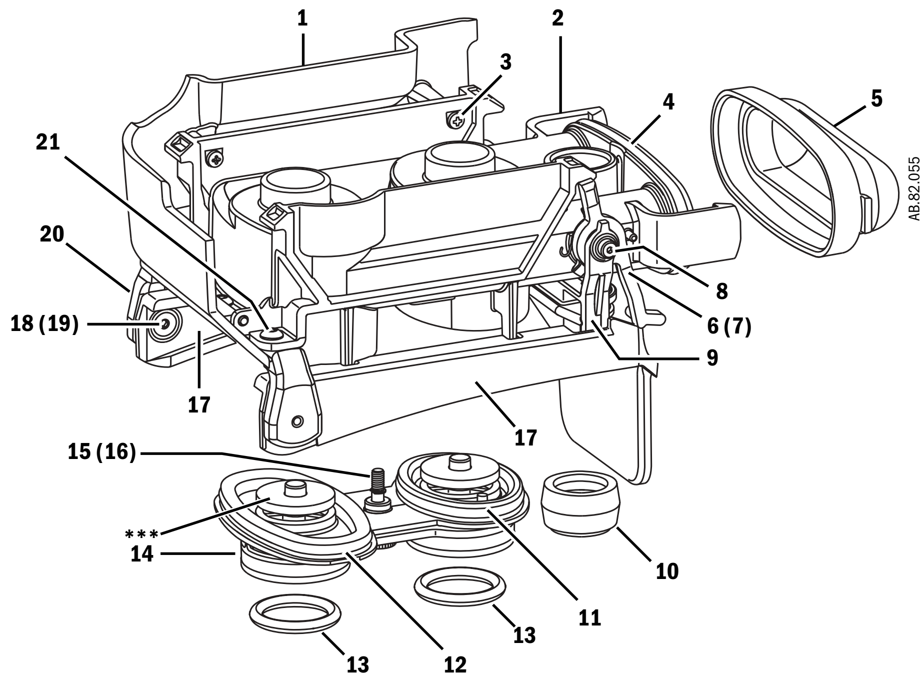
10.22.9 Bag Arms



Item	Description	Stock Number	Qty
1	Bag Arm Assembly (complete)	1009-8159-000	
2	Bag Arm Upper Assembly	1407-7011-000	
2a	Cover, bag port housing	1407-3807-000	
	Screw, M3x20	0140-6719-103	
	Lockwasher, M3 internal	9213-0430-003	
2b	Housing, bag port	1407-3806-000	
2c	Lever, lock release	1407-3808-000	
2d	Ring, retaining	1406-3577-000	
2e	Nut, M3 Nyloc	0144-3536-112	
3	Bag Arm Lower Assembly	1407-7012-000	
3a	Pad, Friction Material	--------------------	
3b	Bag Arm post subassembly	--------------------	
3c	Spring	--------------------	
3d	Washer, shoulder	--------------------	
3e	Nut, M5 Nyloc	--------------------	
4	Pin, dowel 3.18 DIA 31.8 L SST	1407-3804-000	
5*	Screw, M3x20 SKT HD CAP	0144-2124-201	(2)
6	Washer, M3 flat	0144-1003-132	(2)
Items if no Bag Arm			
7	Clip, patient tubing	1407-3810-000	
8	Washer, shoulder	1407-3814-000	
9	Lockwasher, M4 external	9213-0540-003	
10	Screw, M4x16	9211-0440-163	
Accessory items			
11	Bag arm connector, reusable (All except China)	8004459	
	Bag arm connector, reusable (China)	M1082613	

* Apply Loctite 242.

10.22.10 EZchange Canister system (CO_2 Bypass)



Item	Description	Stock Number	Qty
	EZchange Canister module	1407-7021-000	
1	Cover, Bypass Manifold	1407-3123-000	
2	Manifold, Bypass	1407-3113-000	
3	Screw, M3x8 PT PAN PH SST	0142-4254-106	(2)
4**	O-ring, 59.92 ID 66.98 OD 3.53 W SIL 50 DURO	1407-3142-000	
5	Cap, Manifold	1407-3130-000	
6	Lever, Switch Actuator	1407-3116-000	
7	Spring, Torsion Switch Actuator Lever	1407-3117-000	
8*	Screw, M3x0.5 Shoulder 4 DIA X 4 L SST	1407-3915-000	(2)
9	Lever, Canister Latch	1407-3115-000	
10	Seal, Drain	1407-3121-000	
11**	O-ring, 37.69 ID 44.75 OD 3.53 W SIL 50 DURO	1407-3129-000	
12**	O-ring, 50.39 ID 57.45 OD 3.53 W SIL 50 DURO	1407-3143-000	
13**	O-ring, OD30 ID 22 4W SIL 40 DURO	1407-3104-000	(2)
14***	Valve, Housing Assembly Bypass	1407-3126-000	
15	Screw, Thumb M4 Shoulder 7.5 X 7	1407-3410-000	
16	Ring, Retaining 3.96 Shaft DIA SST	1407-3411-000	
17	Cradle Canister	1407-3118-000	
18	Screw, M4x10 CSK SKT HD SST TYPE 316	0140-6226-119	(2)
19**	Spacer, Shoulder 6.8 DIA x4.1 L	1407-3120-000	(2)
20	Support, Cradle Pivot	1407-3119-000	
21	Screw, M4x8 Sems BT SKT HD SST 316	0144-2436-108	(3)

* Apply Loctite 242.

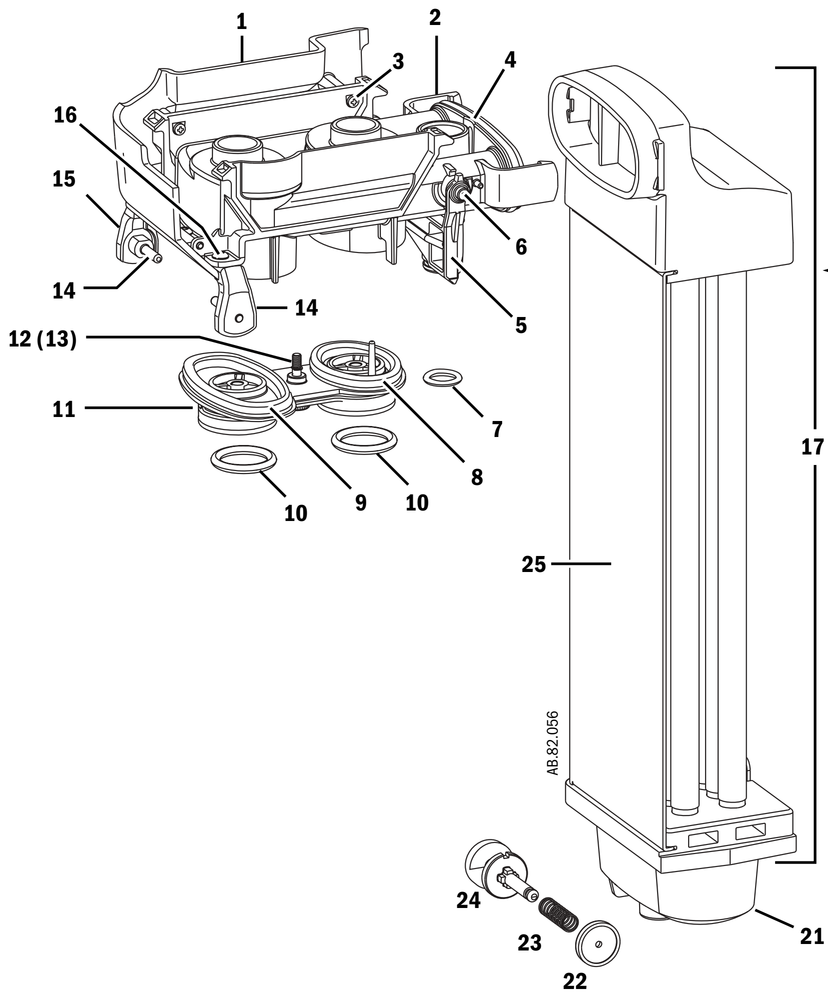
** Lubricate sparingly with Krytox.

*** Rubber valve seats can not be removed from assembly (**Item 14**).

10.22.11 Condenser

Item	Description	Stock Number	Qty
	Condenser assembly (includes all Items)	1407-7026-000	
	Condenser module (Items 1 through 16)	1407-7025-000	
	Condenser (Items 17 through 26)	1407-7024-000	
1	Cover, Bypass Manifold	1407-3123-000	
2	Manifold, Condenser	1407-3114-000	
3	Screw, PT PAN PH M3X8 SST	0142-4254-106	(2)
4**	O-ring, 63.09 ID 70.15 OD	1407-3142-000	
5	Lever, Canister Latch	1407-3115-000	
6*	Screw, M3x0.5 Shoulder 4 DIA X 4 L SST	1407-3915-000	(2)
7	O-ring, 12.37 ID 17.6 OD	1006-3968-000	
8**	O-ring, 37.69 ID 44.75 OD	1407-3129-000	
9**	O-ring, 50.39 ID 57.45 OD	1407-3143-000	
10**	O-ring, 22 ID 30 OD	1407-3104-000	(2)
11	Cap, Valve Housing	1407-3125-000	
12	Screw, Thumb M4 Shoulder 7.5 X 7	1407-3410-000	
13	Ring, Retaining 3.96 Shaft DIA SST	1407-3411-000	
14*	Pin, Condenser Manifold	1407-3131-000	(2)
15	Support, Cradle Pivot	1407-3119-000	
16	Screw, M4x8 Sems BT SKT HD	0144-2436-108	(3)
17	Tube Assembly	1407-3133-000-S	
18	Washer (part of Item 17)	----	(2)
19	Fork (part of Item 17)	----	
20	Screw, M5.28x20 (part of Item 17)	----	
21	Reservoir, Condenser	1407-3137-000	
22	Seal, Condenser Reservoir	1407-3136-000	
23	Spring, Compression Drain Button	1407-3135-000	
24	Button, Drain	1407-3134-000	
25	Cover, Condenser	1407-3138-000	
26	Guard	1407-3145-000	

* Apply Loctite 242.
** Lubricate sparingly with Krytox.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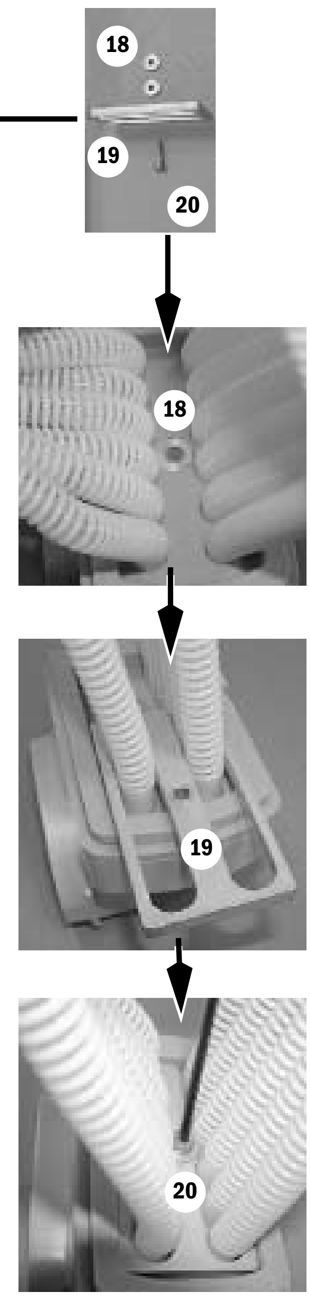
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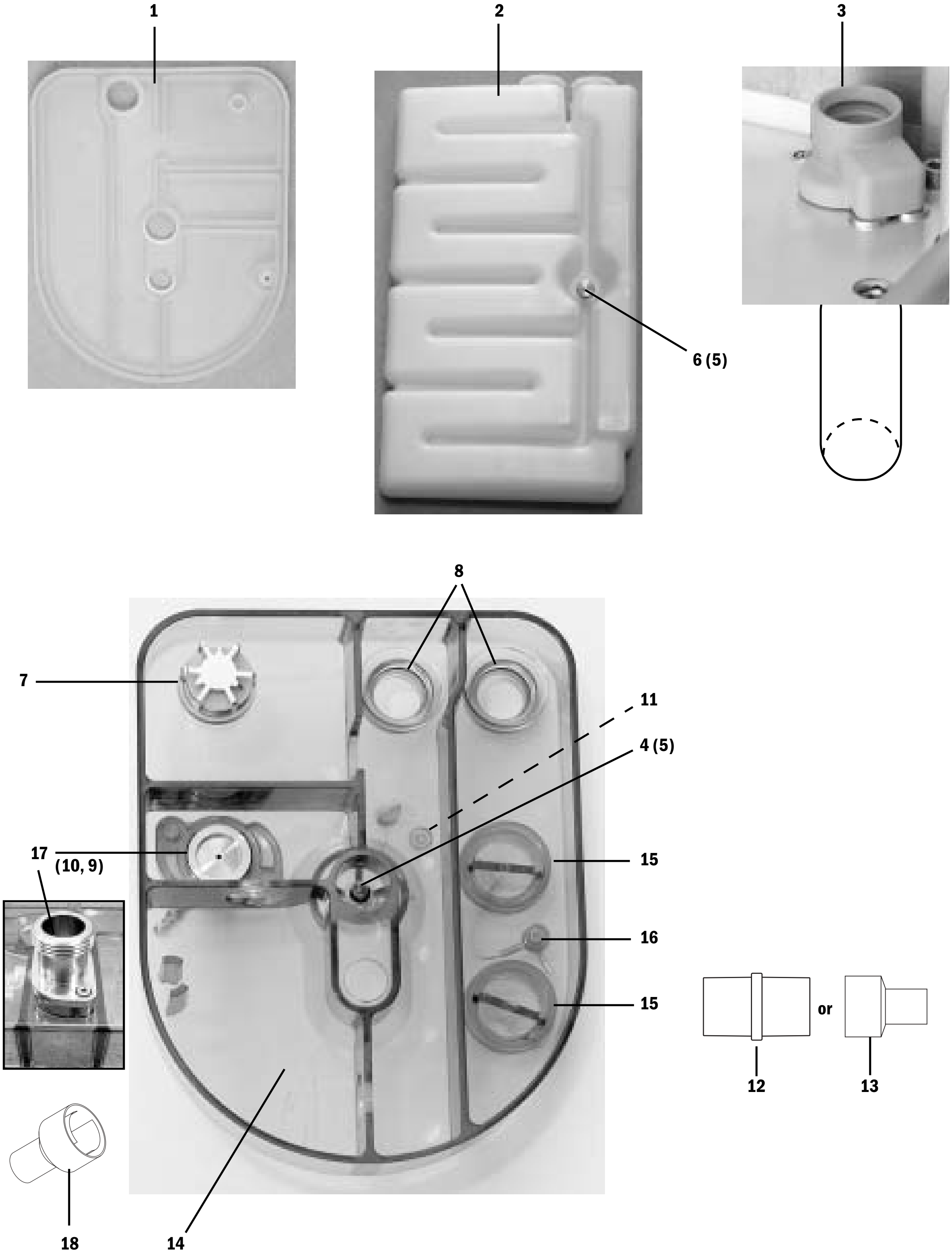
10.22.12 Anesthetic Gas Scavenging System — AGSS

10.22.13 Passive AGSS

Items 1 through 12 are included in all AGSS kits.

Item	Description, Common Parts	Stock Number	Qty
1	Seal, Receiver Body	1407-3901-000	
2	Reservoir	1407-3903-000	
3	Seal and scavenging down-tube	1407-3904-000	
4	Thumbscrew, M6x28.5	1406-3305-000	
5	O-ring, 4.42 ID, 9.65 OD	1407-3923-000	(2)
6	Thumbscrew, M6x43	1406-3304-000	
7	Valve, unidirectional (negative pressure relief)	1406-8219-000	
7a	Seat, Valve, Negative Pressure	1406-3396-000	
7b	Retainer, disc	1400-3017-000	
*7c	O-ring, 20.35 ID, 23.90 OD	1406-3397-000	
7d	Disc, check-valve	0210-5297-100	
8*	O-ring, 22 ID, 30 OD silicone	1407-3104-000	(2)
9*	O-ring, 21.95 ID, 25.51 OD	1406-3558-000	
10	Screw, M4x8	9211-0640-083	(2)
11	Cap, 3.18 Barb, Silicone	1406-3524-000	
12	Adapter, auxiliary inlet, 30-mm male to 30-mm male	M1003134	
13	Adapter, auxiliary inlet, 30-mm male to 19-mm male	M1003947	
Passive AGSS Specific Parts			
14	Receiver, Passive/Adjustable	1407-3908-000	
15	Plug Assembly, tethered	1407-3909-000	(2)
16	Screw, shoulder M3	1407-3915-000	
17	Connector, 30-mm ISO, Male	1406-3555-000	
18	Adapter, scavenging, 30-mm female to 19-mm male	1500-3376-000	(5 pack)

* Lubricate sparingly with Krytox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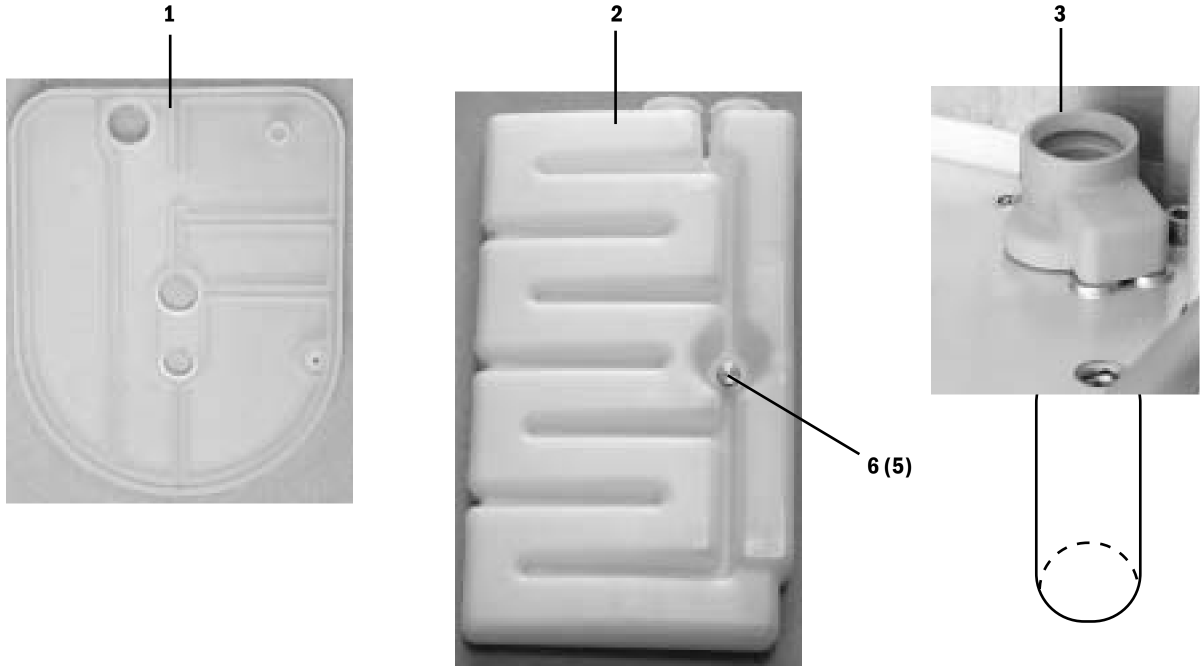
10.22.14 Adjustable AGSS

Items 1 through 12 are included in all AGSS kits.

Item	Description, Common Parts	Stock Number	Qty
1	Seal, Receiver Body	1407-3901-000	
2	Reservoir	1407-3903-000	
3	Seal and scavenging down-tube	1407-3904-000	
4	Thumbscrew, M6x28.5	1406-3305-000	
5	O-ring, 4.42 ID, 9.65 OD	1407-3923-000	(2)
6	Thumbscrew, M6x43	1406-3304-000	
7	Valve, unidirectional (negative pressure relief)	1406-8219-000	
7a	Seat, Valve, Negative Pressure	1406-3396-000	
7b	Retainer, disc	1400-3017-000	
*7c	O-ring, 20.35 ID, 23.90 OD	1406-3397-000	
7d	Disc, check-valve	0210-5297-100	
8*	O-ring, 22 ID, 30 OD silicone	1407-3104-000	(2)
9*	O-ring, 21.95 ID, 25.51 OD	1406-3558-000	
10	Screw, M4x8	9211-0640-083	(2)
11	Cap, 3.18 Barb, Silicone	1406-3524-000	
12	Adapter, auxiliary inlet, 30-mm male to 30-mm male	M1003134	
13	Adapter, auxiliary inlet, 30-mm male to 19-mm male	M1003947	
Adjustable AGSS Specific Parts			
14	Receiver, Passive/Adjustable	1407-3908-000	
15	Plug Assembly, tethered	1407-3909-000	
16	Screw, shoulder M3	1407-3915-000	
17	Needle Valve Assembly (with DISS EVAC connector)	1407-3918-000	
18	Bag with 30 mm male connector	8004460	

* Lubricate sparingly with Krytox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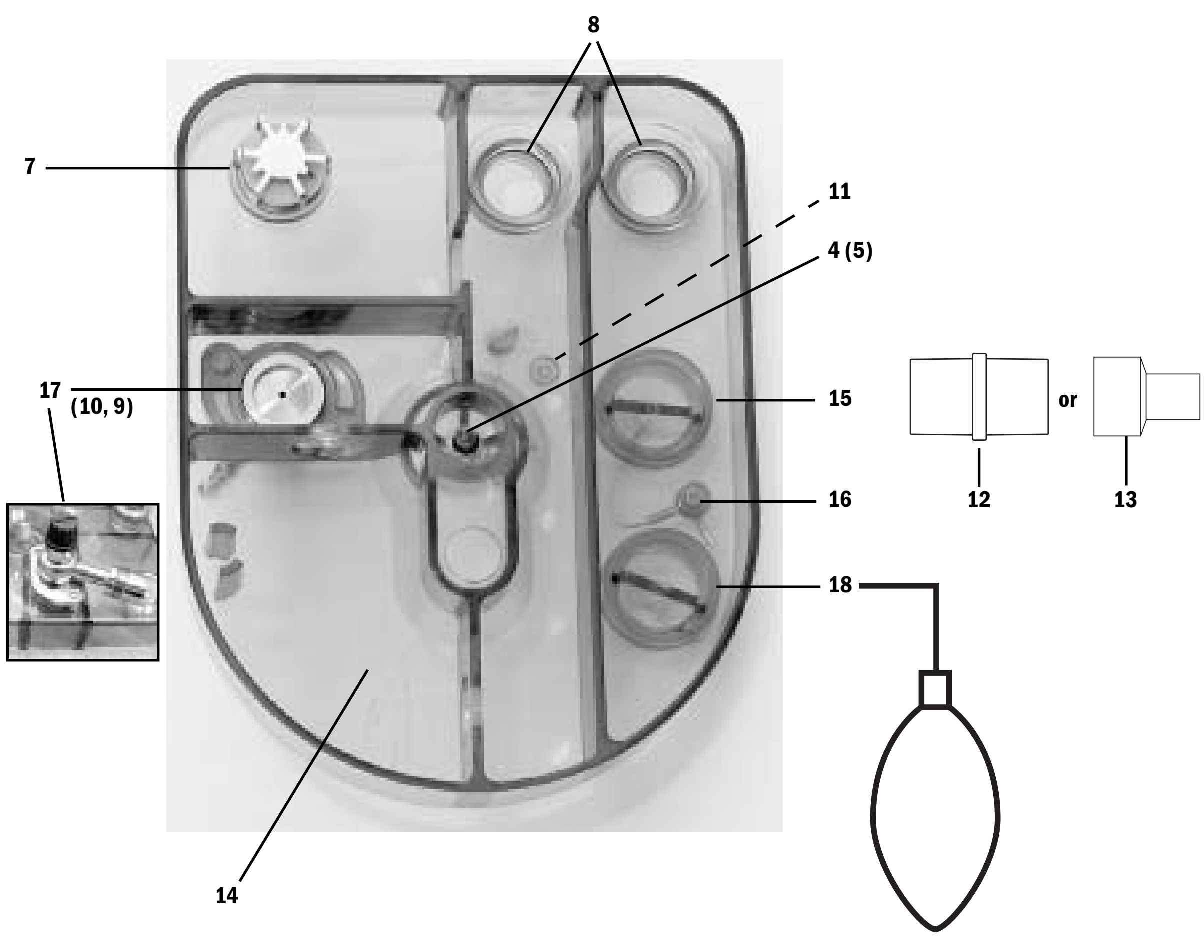
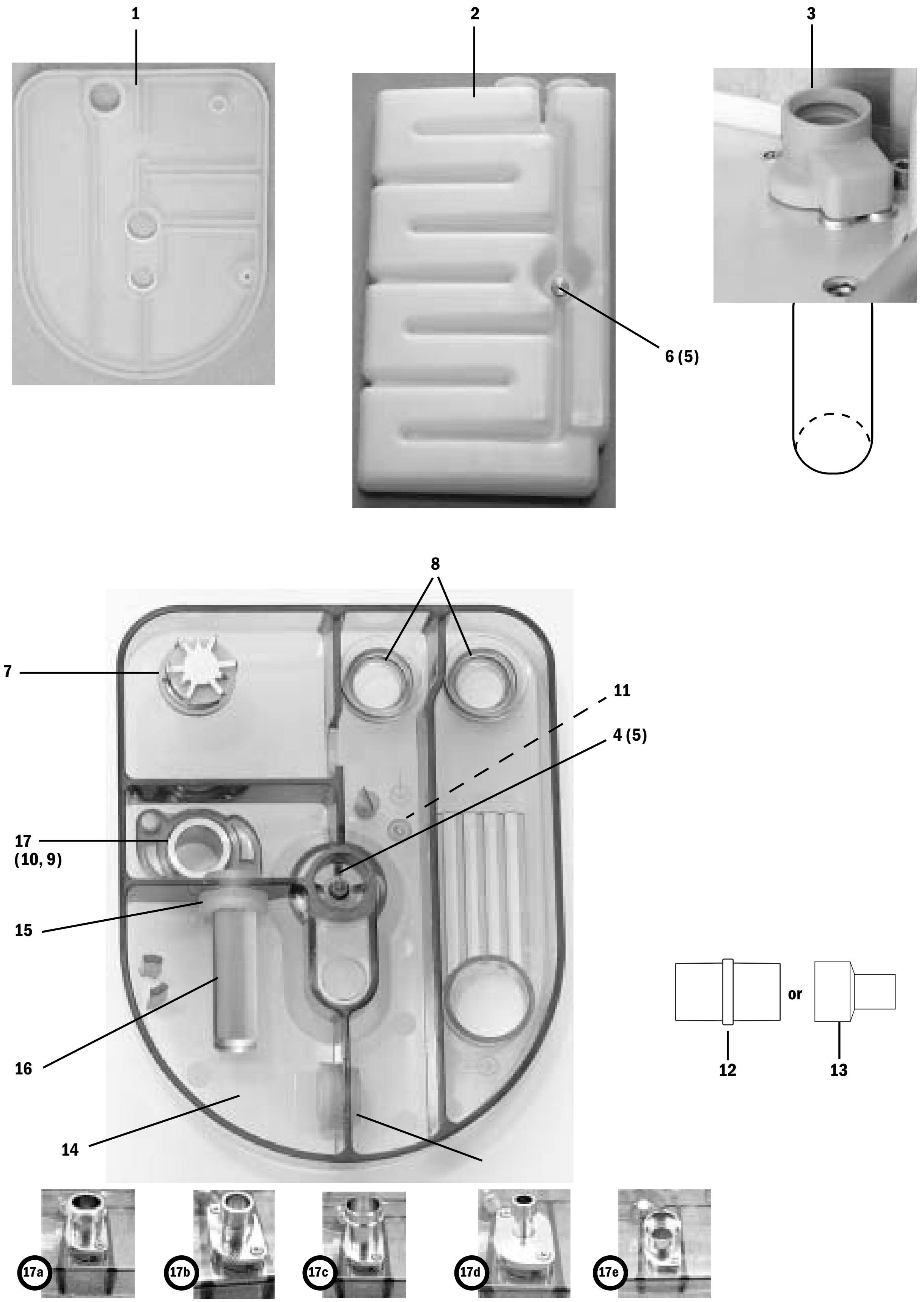

8
7
11
4 (5)
17
(10, 9)
15
or
12
13
16
18
14

10.22.15 Active AGSS

Items 1 through 12 are included in all AGSS kits.

Item	Description, Common Parts	Stock Number	Qty
1	Seal, Receiver Body	1407-3901-000	
2	Reservoir	1407-3903-000	
3	Seal and scavenging down-tube	1407-3904-000	
4	Thumbscrew, M6x28.5	1406-3305-000	
5	O-ring, 4.42 ID, 9.65 OD	1407-3923-000	(2)
6	Thumbscrew, M6x43	1406-3304-000	
7	Valve, unidirectional (negative pressure relief)	1406-8219-000	
7a	Seat, Valve, Negative Pressure	1406-3396-000	
7b	Retainer, disc	1400-3017-000	
*7c	O-ring, 20.35 ID, 23.90 OD	1406-3397-000	
7d	Disc, check-valve	0210-5297-100	
8*	O-ring, 22 ID, 30 OD silicone	1407-3104-000	(2)
9*	O-ring, 21.95 ID, 25.51 OD	1406-3558-000	
10	Screw, M4x8	9211-0640-083	(2)
11	Cap, 3.18 Barb, Silicone	1406-3524-000	
12	Adapter, auxiliary inlet, 30-mm male to 30-mm male	M1003134	
13	Adapter, auxiliary inlet, 30-mm male to 19-mm male	M1003947	
Active AGSS Specific Parts			
14	Receiver, with air brake	1407-3900-000	
15	Seal, for filter and orifice	1407-3902-000	(2)
16	Filter	1406-3521-000	
Active High Flow Specific Parts			
17a	Connector, high flow M30 thread	1406-3557-000	
18	Orifice, high flow	1407-3920-000	
Active Low Flow with EVAC connector Specific Parts			
17b	Connector, low flow EVAC	1406-3597-000	
18	Orifice, low flow	1407-3919-000	
Active Low Flow with 25 mm connector Specific Parts			
17c	Connector, low flow 25 mm	1406-3573-000	
18	Orifice, low flow	1407-3919-000	
Active Low Flow with 12.7 mm hose barb connector Specific Parts			
17d	Connector, low flow 12.7 mm (1/2 inch)	1406-3574-000	
18	-none-		
Active Low Flow with 30 mm ISO male connector Specific Parts			
17e	Connector, 30 mm ISO, Male	1406-3555-000	
18	Orifice, low flow	1407-3919-000	

* Lubricate sparingly with Krytox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or
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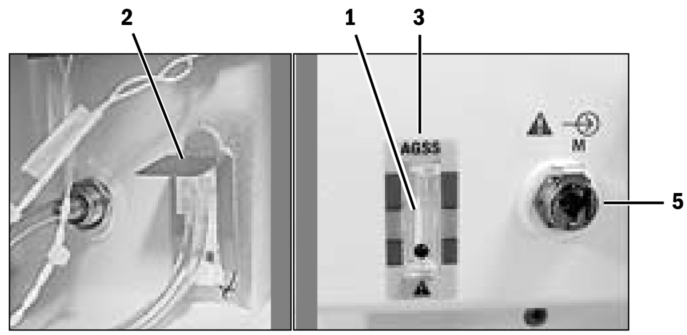
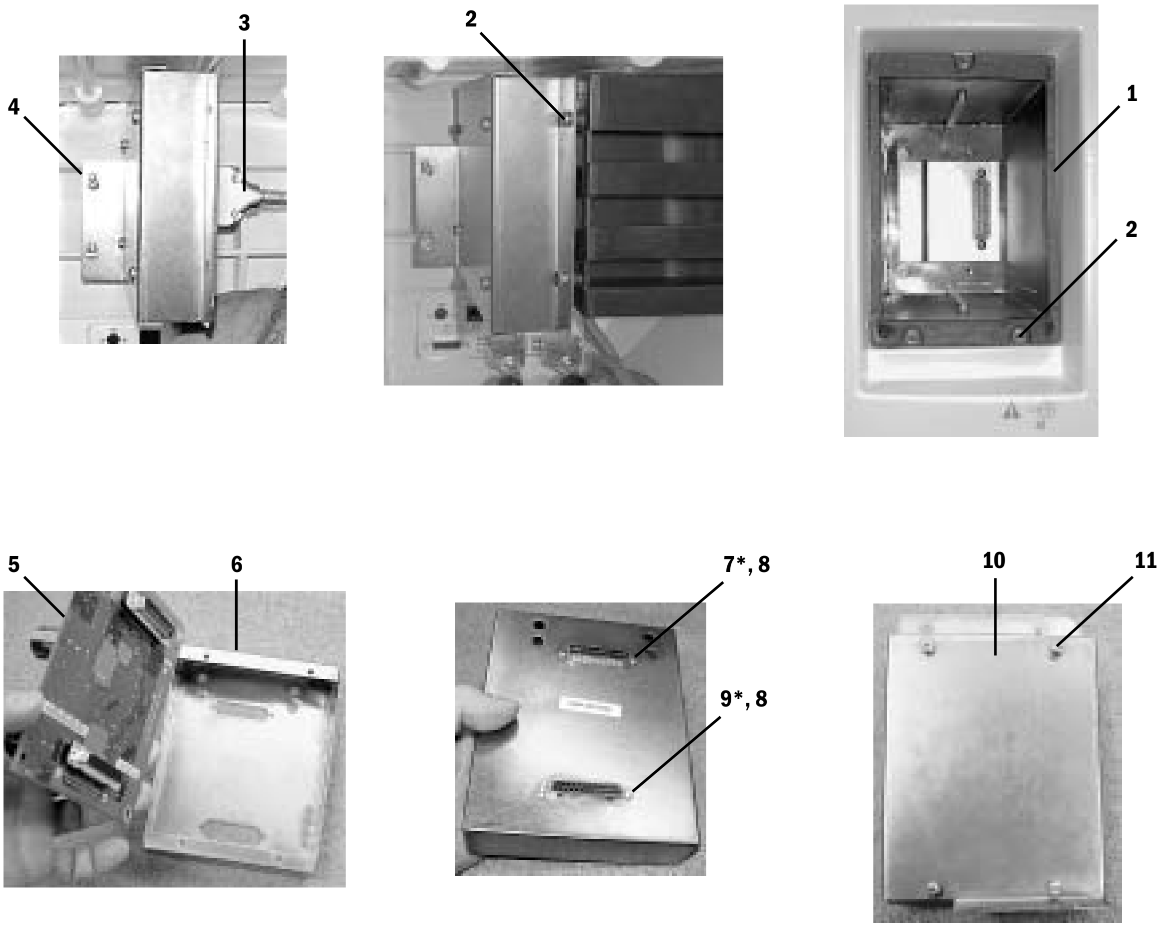
17a
17b
17c
17d
17e

10.22.16 AGSS gauge, and sample return



Item	Description	Stock Number
1	Flowtube, AGSS	1406-3560-000
2	Clip, AGSS flowtube	1009-3181-000
3	Label, flow indicator AGSS Label, flow indicator AGFS (for German variant) Label, blank (for machines without flow indicator)	1406-3527-000 1009-3301-000 1009-3241-000
4	Label, AGFS (for German variant)	1009-3300-000
5	Coupling, Colder (Kit includes mounting nut)	1009-8321-000

10.22.17 Airway module (MGAS) components

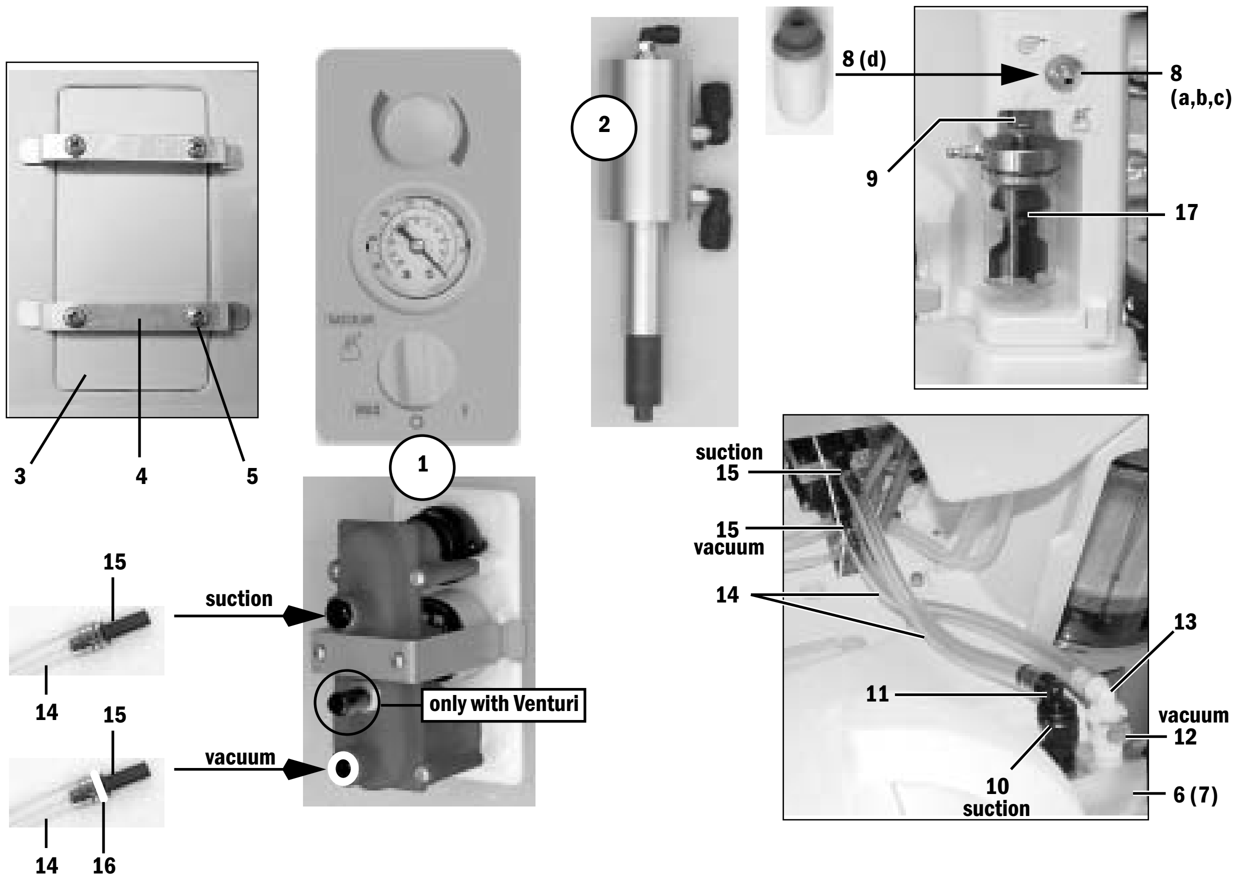


Item	Description	Stock Number
1	Guide, MGAS module	1009-3072-000
2	Screw, M4x8	1006-3178-000
3	Cable, MGAS to Connector board	1009-5555-000
4	Screw, M4x12 THD FORMING	1009-3109-000
5	MGAS monitoring board	1009-5573-000
6	Box, MGAS power supply	1009-3092-000
7*	Screw, 4-40	0140-6617-103
8	Lockwasher, #4 split	0144-1104-331
9*	Standoff	1504-3007-000
10	Cover, MGAS power supply	1009-3093-000
11	Screw, M4x8	0140-6226-113

* Apply Loctite 242.

10.23 Integrated Suction Regulator

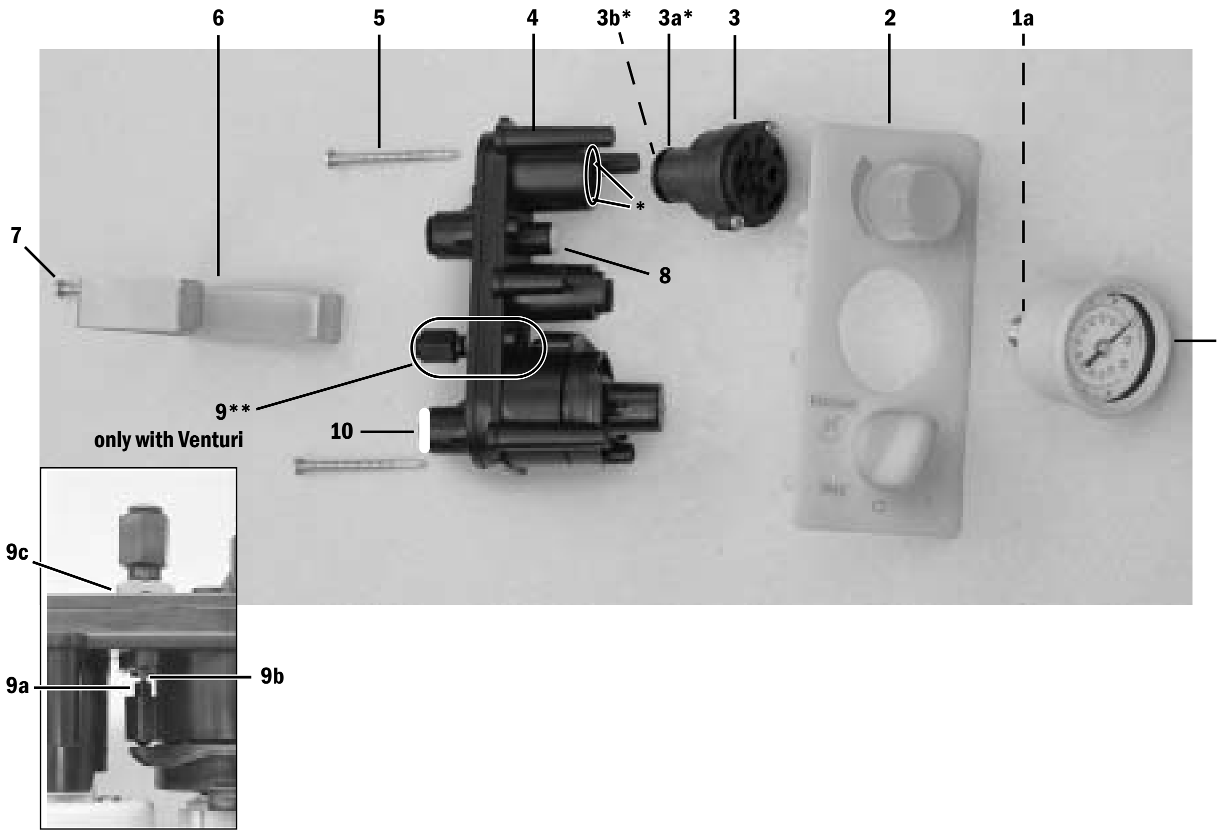
10.23.1 Major Components (Continuous and Venturi suction)



Item	Description	Stock Number
1	Suction Control Module	Refer to section 10.23.2
2	Venturi Assembly	Refer to section 10.23.3
3	Cover, blank (if no Suction)	1009-3271-000
4	Bracket, blank cover mounting	1009-3270-000
5	Screw, M4x10 self-tapping	1009-5534-000
6	Manifold	1009-3123-000
7	Screw, M5x20 BHSCS PT THD FORMING	1009-3384-000
8a*	Connector, NIST	1011-3524-000
8b*	Connector, Barb	0221-0702-300
8c*	Connector, Air Liquide	1009-8292-000
8d	Muffler, for Venturi Drive	1011-3511-000
9	Coupling, Colder insert metal	1009-3135-000
10	Coupling, Colder body black	1009-3373-000
11	Coupling, Colder insert black	1009-3374-000
12	Coupling, Colder body white	1009-3371-000
13	Coupling, Colder insert white	1009-3372-000
14	Tubing, Tygon	Refer to section 10.31
15	Fitting, barb to 8-mm Legris	1009-3137-000
16	Cap, white	1009-3385-000
17	Overflow Safety Trap	6700-0647-800

* Apply Teflon tape to threads (not 8d)

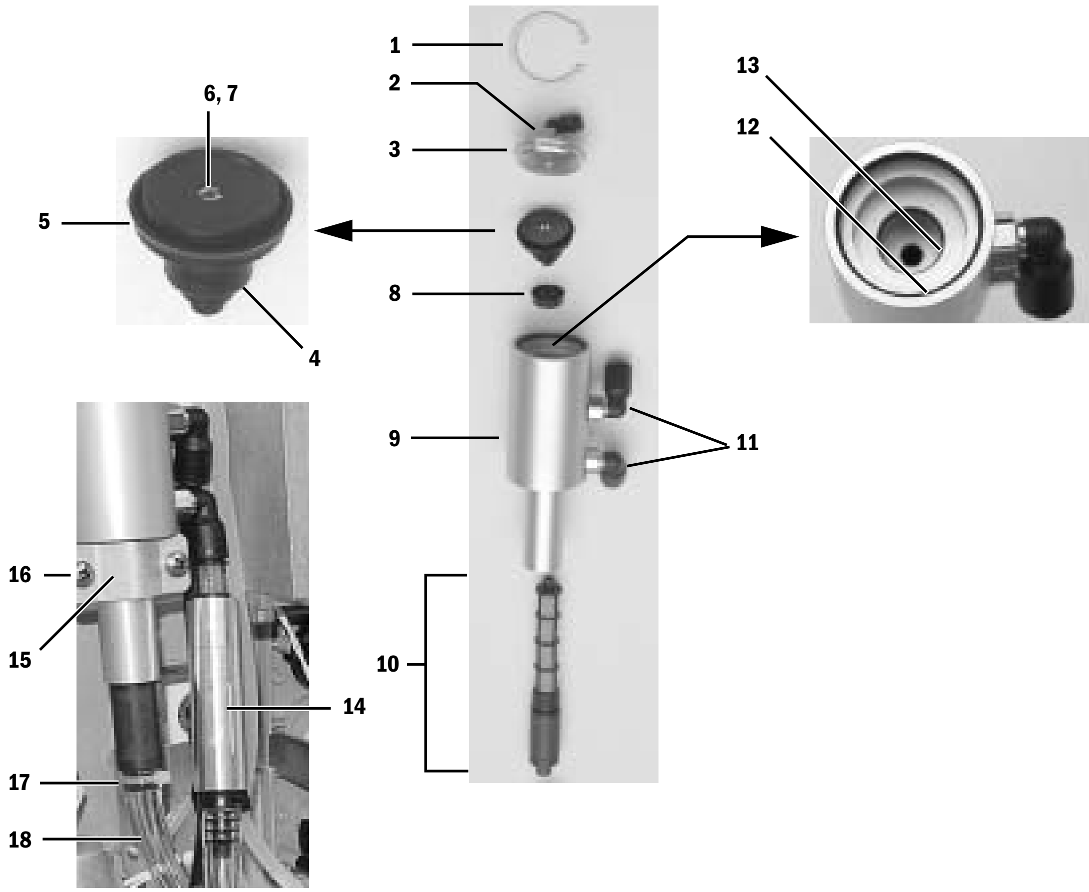
10.23.2 Suction Control Module



Item	Description	Stock Number
1	Gauge, 760 mmHg	1009-3227-000
	Gauge, 1 Bar	1009-3228-000
1a	O-ring, Gauge (included with gauge assy, 2ea. required)	6700-0133-500
2	Control panel assembly, with suction regulator knob and mode control knob	1009-3213-000
3	Regulator Module (plugs into manifold assembly)	6700-1225-800
3a	O-ring, Regulator Module, Large (included with regulator module)	6700-0136-500
3b	O-ring, Regulator Module, Stem (included with regulator module)	0210-0527-300
4	Manifold Assembly, without Gauge and Regulator Module	1009-3277-000
5	Screw, #6 - 2 inch	1009-3340-000
6	Mounting bracket	1009-3255-000
7	Screw, #6 - 1 inch	1009-3339-000
8	Filter	0206-5159-300
9	Pilot valve adapter assembly (includes plunger, jam nut, and valve assembly)	1009-3278-000
10	Cap, white	1009-3192-000

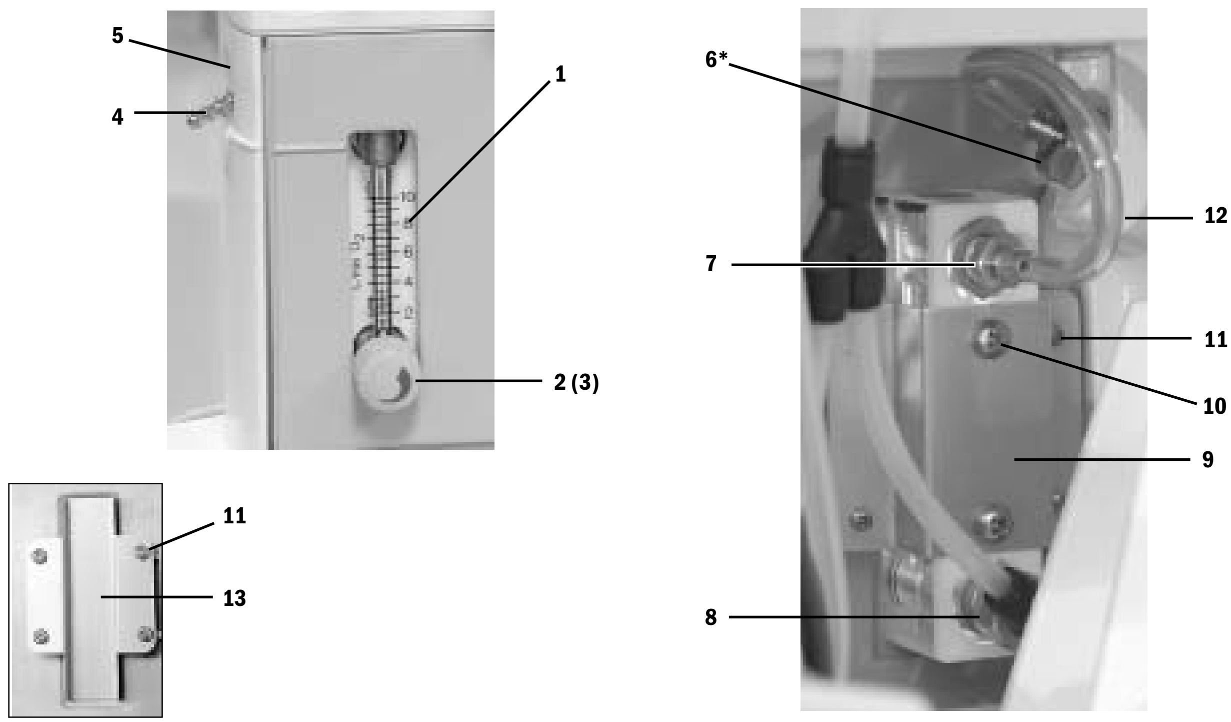
* Lubricate the regulator module o-rings and the mating bore of the manifold sparingly with Dow 111 lubricant.
** Drop the plunger (**9a**), round end first, into the manifold. Thread the pilot valve into the manifold body. Set the mode switch to raise the plunger. Adjust the pilot valve (**9b**) so that the plunger actuates the pilot valve approximately half of its travel. Tighten the jam nut (**9c**).

10.23.3 Venturi assembly



Item	Description	Stock Number
1	C-clip retainer, Truarc	1500-3158-000
2	Elbow fitting, 4-mm Legris	1006-3663-000
3	Cap	1011-5002-000
4	Spoppet	1011-5001-000
5	Seal, u-cup large	1503-3090-000
6	Orifice	1011-3508-000
7	Screen, 150 mesh monel	1001-3808-000
8	Seal, u-cup small	1503-3089-000
9	Body	1011-5000-000
10	Venturi	1011-3509-000
11	Elbow fitting, 8-mm Legris	1011-3510-000
12	O-ring, large	9221-3032-116
13	O-ring, small	1503-3108-000
14	Check valve	1011-8002-000
15	Bracket, Venturi mounting	1009-3182-000
16	Screw, M5x20 BHSCS PT THD FORMING	1009-3384-000
17	Cable tie	0203-5915-300
18	Tubing, Tygon	Refer to section 10.31

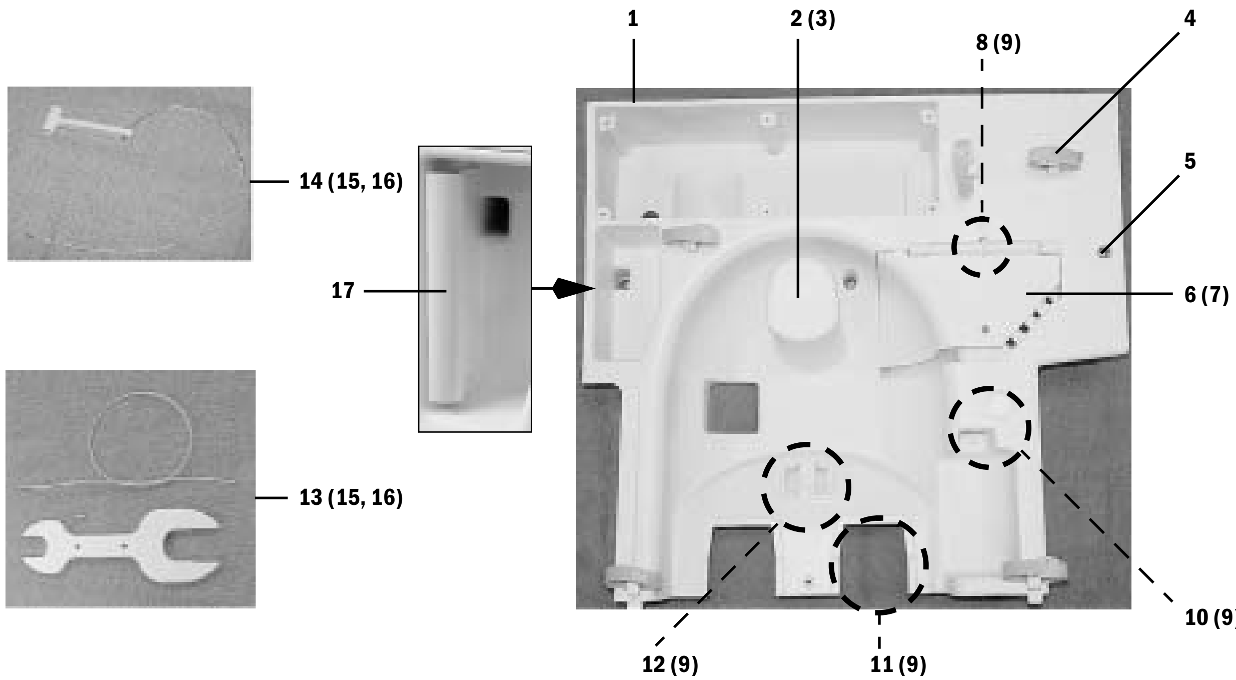
10.24 Auxiliary O_2 Flowmeter



Item	Description	Stock Number
1	Flowmeter, 1-10 L/min, Complete with fittings installed Flowmeter, 1-10 L/min, without fittings	1006-8424-000 1006-3841-000
2	Knob, gray	1011-3471-000
3	Set Screw	9211-0830-053
4	Nipple, Panel-Mount, Auxiliary O_2 Outlet	1006-5177-000
5	Label, blank (if no Auxiliary O_2)	1009-3243-000
6*	Nut, M12x1.75, SST	0144-3132-140
7**	Flowmeter Fitting, 1/8 NPTM straight adapter Flowmeter Fitting, 1/8 NPTM elbow adapter	0204-8877-300 0204-8788-300
8**	Flowmeter Fitting Assembly, 6-mm Tubing Adapter	1006-8423-000
9	Plate, Flowmeter Mounting	1009-3126-000
10	Screw, 10-32 x 3/8	0140-6631-107
11	Screw, M4x10 self-tapping	1009-5534-000
12	Tubing (low-pressure) 250 mm - 1/4 inch	1605-1001-000
13	Plate, blank (if no Auxiliary O_2)	1009-3128-000

* Apply Loctite 242.
** Apply Teflon tape.

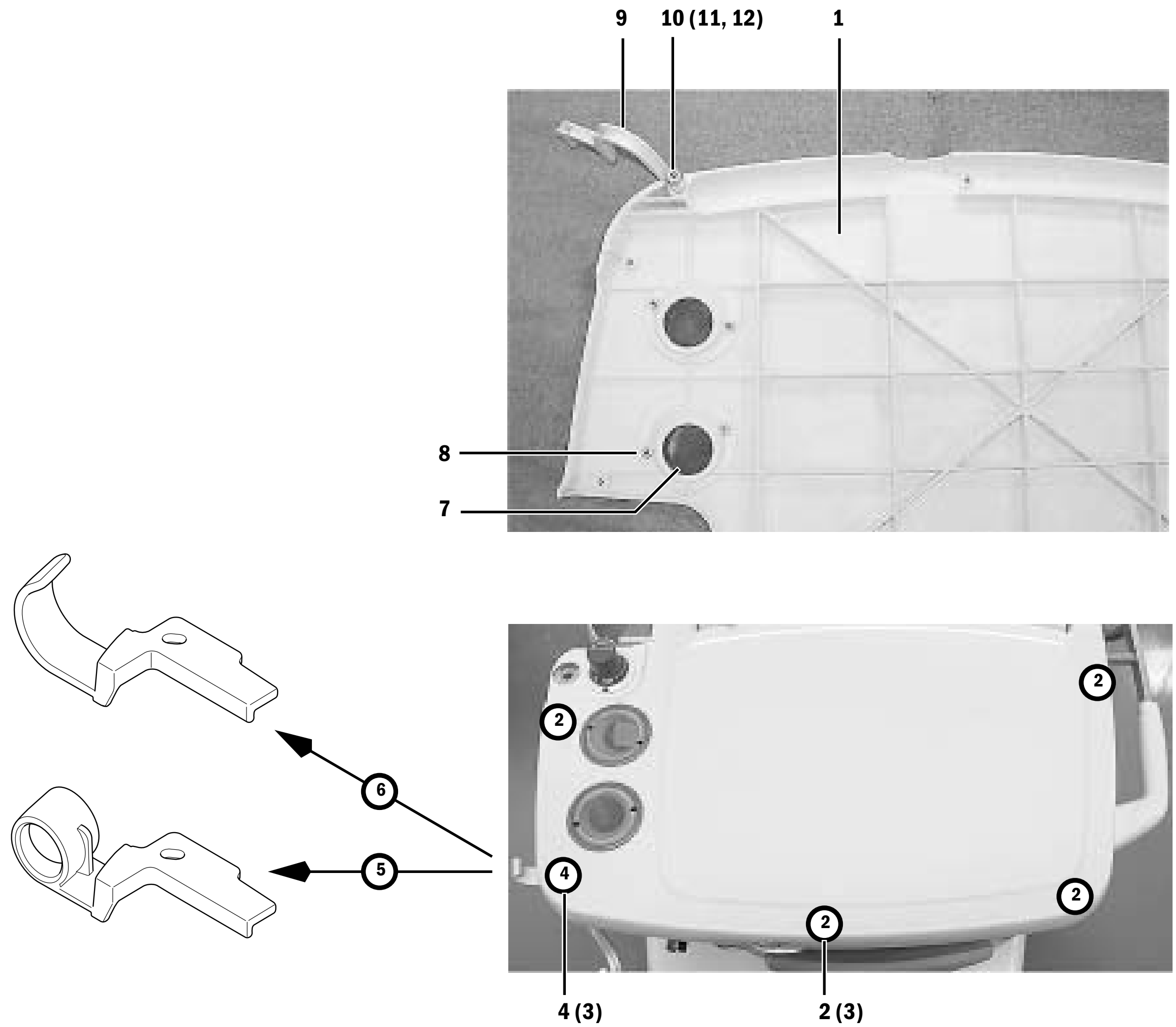
10.25 Rear panel components



Item	Description	Stock Number
1	Cover, rear upper	1009-3073-000
2	Cap, hose reel	1009-3075-000
3	Screw, M5.5x20	1009-3384-000
4	Strap, hook/loop	1009-3233-000
5	Screw, M6x1.0 captive	1009-3114-000
6	Door, access (not functional for Aespire)	1009-3074-000
7	Screw, M4x12	1009-3109-000
8	Spring, cantilever	1009-3124-000
9	Screw, M3x8	0142-4254-106
10	Cover, trap bottle (if no internal suction)	1009-3173-000
11	Cover, regulator yoke (if no regulator)	1009-3121-000
12	Plate, clip cover	1009-3185-000
13	Wrench, DIN cylinder (without cable)	1202-3651-000
14	Wrench, pin index cylinder (with cable)	0219-3415-800
15	Cable	1010-3049-000
16	Ferrule, cylinder wrench cable retainer	1001-3708-000
17*	Handle, P-grip	1009-3343-000

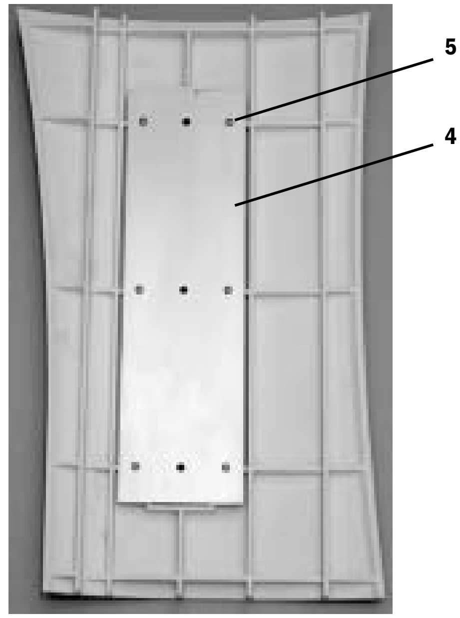
* Clean mounting surface with isopropyl alcohol.

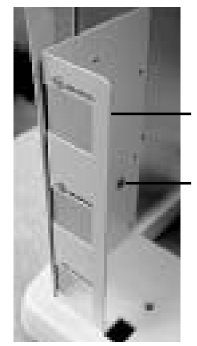
10.26 Tabletop components



Item	Description	Stock Number
1	Tabletop, work surface	1009-3029-000
2	Screw, relieved M4x12	1504-3001-000
3	Washer, retainer	1009-3178-000
4a	Screw, relieved M4x16	1011-3980-000
4b	Washer, M5 flat	1006-1459-000
5	Clip (used with bag arm)	1009-3142-000
6	Clip (used with bag on tube)	1009-3139-000
7	Window, check-valve	1009-3088-000
8	Palnut	1009-3090-000
9	Hook, breathing circuit	1009-3086-000
10	Bolt, shoulder	1009-3172-000
11	Washer, wave	1009-3035-000
12	Washer, Nylon	1009-3150-000

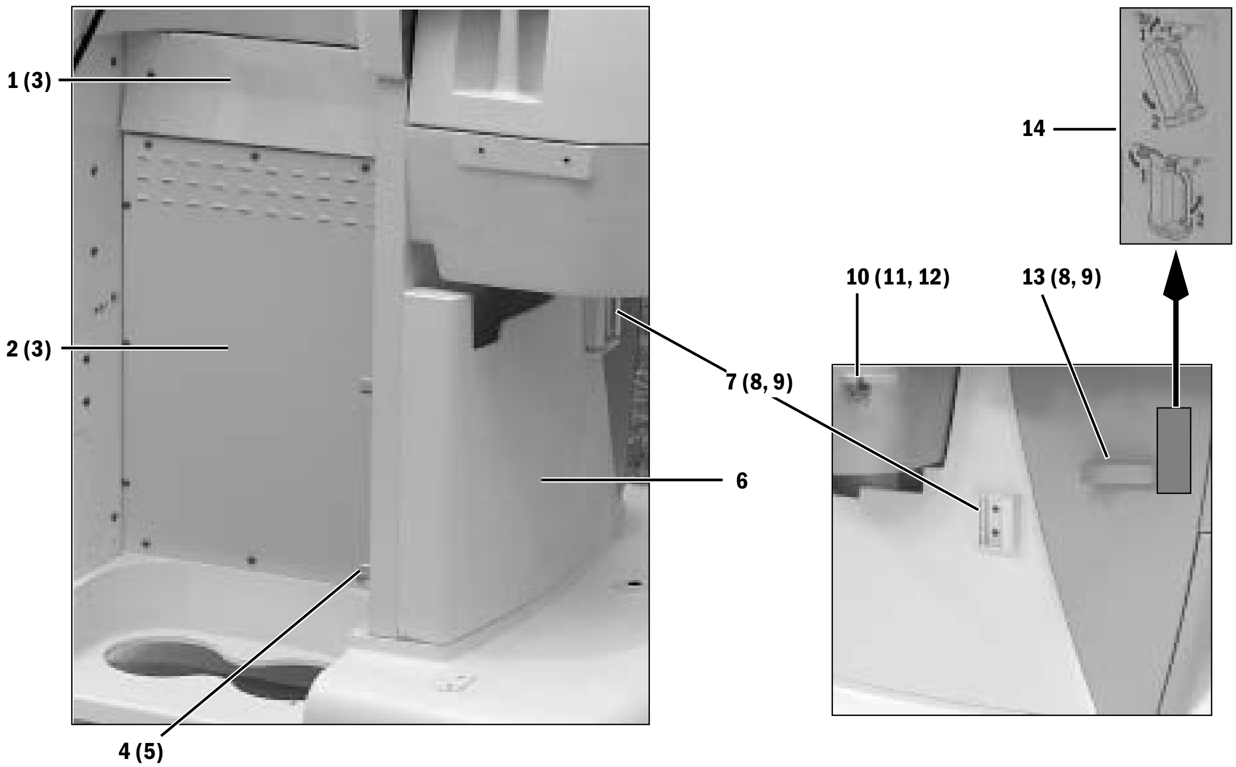
10.27 Right-side Components





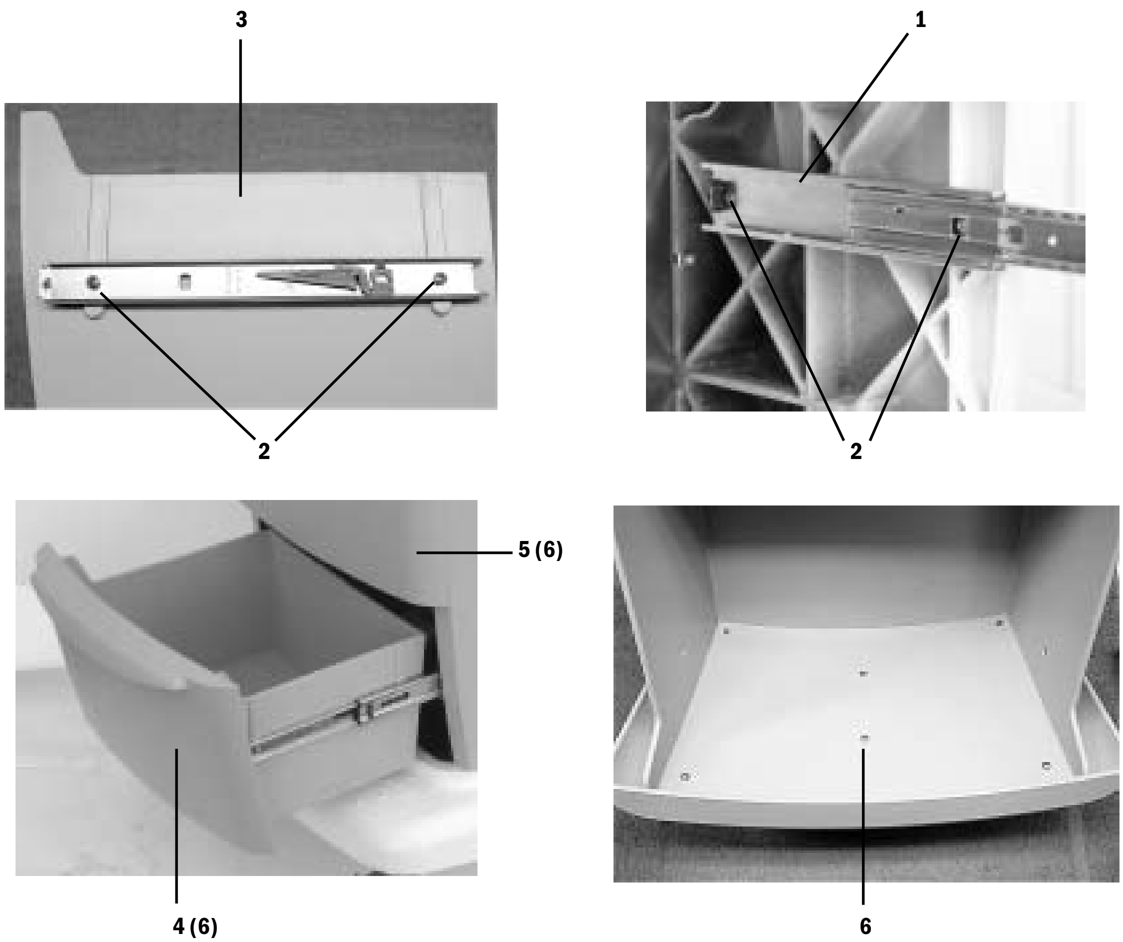
Item	Description	Stock Number
1	Extrusion cover	1009-3021-000
2	Screw, M6x20	0144-2131-921
3	Lockwasher, M6 internal	0144-1118-130
4	Dovetail, RH upright	1009-3129-000
5	Screw, self tapping	1009-5534-000
6	Cover, pipeline inlet	1009-3091-000
7	Screw, M4x8	1006-3178-000

10.28 External components - lower assembly



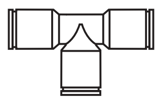
Item	Description	Stock Number
1	Panel, access	1009-3059-000
2	Panel, service	1009-3141-000
3	Screw, M4x8	1006-3178-000
4	Thumbscrew	1406-3304-000
5	Ring, retaining	1406-3319-000
6	Cover, scavenger reservoir	1009-3027-000
7	Bracket, suction reservoir	1009-3107-000
8	Screw, M4x16	9211-0440-163
9	Lockwasher, M4 external	9213-0540-003
10	Clip, suction bag hose	1407-3327-000
11	Screw, M5x16 PAN HD	9211-8350-163
12	Lockwasher, M5 external;	0144-1118-220
13	Bumper, absorber	1009-3105-000
14	Label, CO_2 canister	1011-3946-000

10.29 Drawer

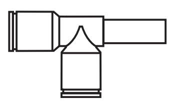


Item	Description	Stock Number
1	Slide, drawer	1009-3084-000
2	Screw, M4x8 Nyloc	1009-3183-000
3	Drawer, body	1009-3078-000
4	Drawer Front, lower (with down arrow on back)	1009-3032-000
5	Drawer Front, upper (with up arrow on back)	1009-3031-000
6	Screw, M4x12	1009-3109-000

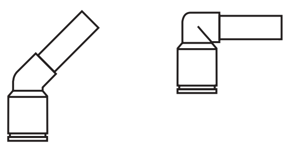
10.30 Legris quick-release fittings



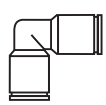
Item	Description	Stock Number
1	**Tees — (tube/tube/tube)**	
	4 mm (N_2O)	1202-3653-000
	6 mm (O_2)	1006-3544-000
	8 mm (Air)	1006-3545-000
	8 mm/6 mm/8 mm (SCGO pilot)	1009-3297-000
	3/16 inch (CO_2 and Heliox)	0213-4727-300



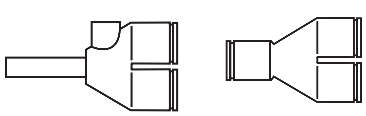
2	**Tees — (tube/tube/standpipe)**	
	6 mm (O_2)	1006-3862-000
	8 mm (Air - Drive gas)	1009-3370-000



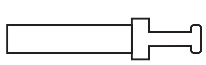
3	**Elbow — (tube/standpipe)**	
	4 mm (N_2O)	1006-3533-000
	6 mm (O_2)	1006-3534-000
	8 mm (Air)	1006-3535-000
	1/4 inch (mixed gas)	1006-3737-000
	1/4 inch (45° - mixed gas)	1009-3368-000



4	**Elbow — (tube/tube)**	
	1/4 inch (mixed gas)	1202-3804-000
	4 mm (N_2O)	1009-3040-000
	6 mm (O_2)	1009-3041=000



5	**Y**	
	6 mm (O_2)	1009-3043-000
	8 mm (Air)	1009-3044-000
	8 mm Y with tailpiece	1009-3360-000
	1/4 inch (mixed gas)	1006-3065-000



6	**Plug**	
	4 mm (N_2O)	1006-3530-000
	6 mm (O_2)	1006-3531-000
	8 mm (Air)	1006-3532-000
	3/16 inch (CO_2 and Heliox)	1006-3835-000

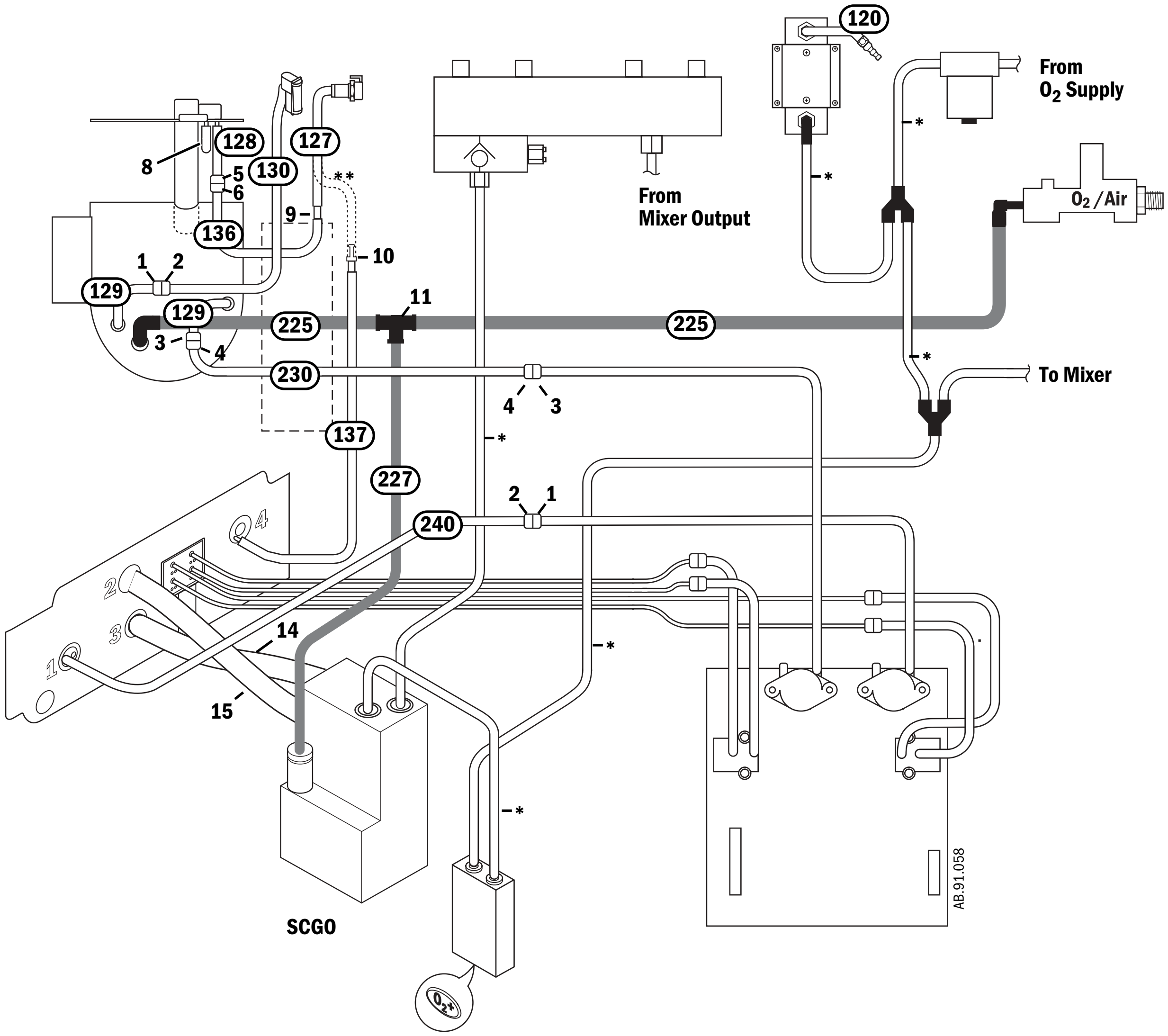
Note: Not every fitting is used in all machines.

10.31 Vent Drive and low-pressure tubing

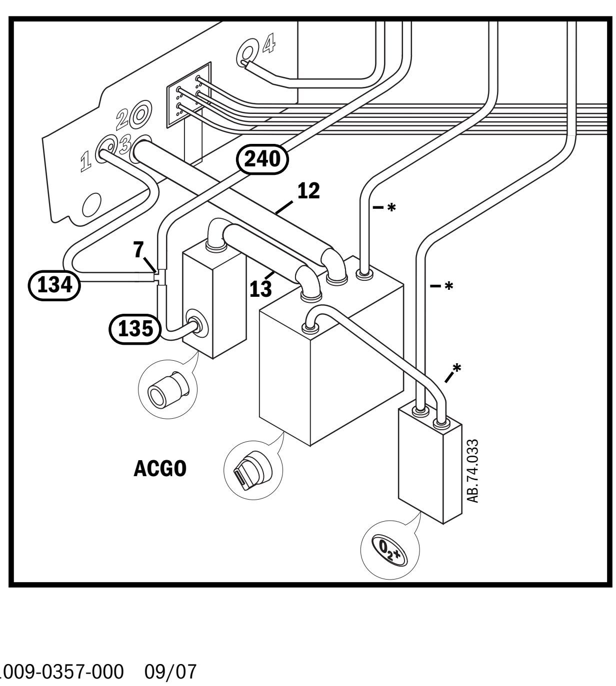
Item	Description		Length — Size	Stock Number
1	Coupler, female - black			1503-3128-000
2	Coupler, male - black			1503-3237-000
3	Coupler, female - white			1503-3119-000
4	Coupler, male - white			1503-3236-000
5	Coupler, female - yellow			1503-3132-000
6	Coupler, male - yellow			1407-3330-000
7	Tee (male barb)			1009-3011-000
8	Cap, plug			1406-3524-000
9	Fitting, coupler barb ends			1009-3077-000
10	Plug, 4-mm			1006-3530-000
11	Tee (8mm/6mm/8mm)			1009-3297-000
12	Tubing (silicone)		72 mm - 3/8 inch	1009-3164-000
13	Tubing (silicone)		42 mm - 3/8 inch	1009-3164-000
14	Tubing (silicone)		100 mm - 3/8 inch	1009-3164-000
15	Tubing (silicone)		110 mm - 3/8 inch	1009-3164-000
	Tube Markings (factory build only)		**Length — Size**	
120	Aux O2 OUT	(low-pressure)	250 mm - 1/4 inch	1605-1001-000
127	RGM return	(low-pressure)	750 mm - 1/4 inch	1605-1001-000
128	unmarked	(low-pressure)	300 mm - 1/4 inch	1605-1001-000
129	unmarked	(low-pressure)	151 mm - 1/4 inch	1605-1001-000
130	AGSS flowtube	(low-pressure)	750 mm - 1/4 inch	1605-1001-000
134	unmarked	(low-pressure)	25 mm - 1/4 inch	1605-1001-000
135	unmarked	(low-pressure)	50 mm - 1/4 inch	1605-1001-000
136	RGM to Scavenge	(low-pressure)	200 mm - 1/4 inch	1605-1001-000
137	RGM to Circuit	(low-pressure)	300 mm - 1/4 inch	1605-1001-000
144	Venturi Pilot	(black)	330 mm - 4 mm	1009-3363-000
145	Venturi Drive	(black)	300 mm - 8 mm	1009-3296-000
146	unmarked	Tygon	260 mm - 1/2 inch	6700-0005-300
148	unmarked	Tygon	465 mm - 1/2 inch	6700-0005-300
149	unmarked		40 mm - 8 mm	1001-3063-000
150	unmarked	Tygon	180 mm - 1/2 inch	6700-0005-300
225	VENT DRIVE	(black)	440 mm - 8 mm	1009-3296-000
227	SCGO PILOT	(black)	320 mm - 6 mm	1009-3295-000
230	MANIFOLD PRESS	(low-pressure)	300 mm - 1/4 inch	1605-1001-000
240	PAW	(low-pressure)	500 mm - 1/4 inch	1605-1001-000

* Refer to section 10.32

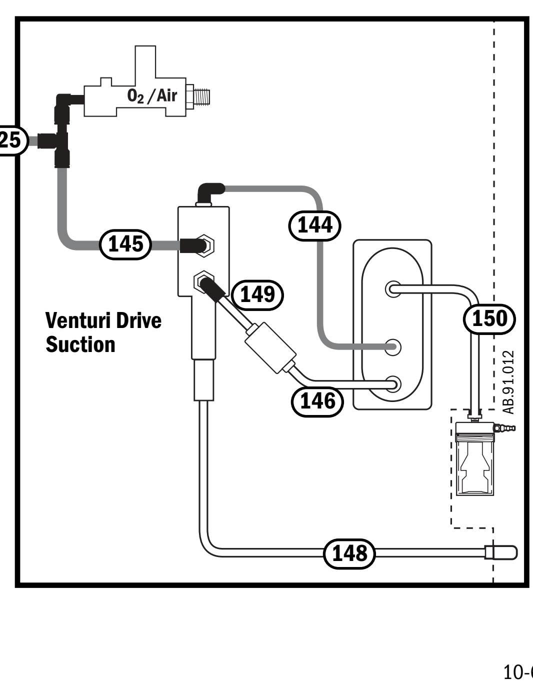
** Sample gas return is directed to the scavenging system as a factory default. A qualified service representative can reroute the sample gas back to the breathing system (refer to Section 9.26).



120
From
O_2 Supply
128
127
8
130
5
6
**
9
136
10
1
2
129
11
129
225
225
3
4
230
4
3
137
227
2
1
240
14
15
From
Mixer Output
O_2 / Air
To Mixer
SCGO
AB.91.058



240
12
7
134
13
135
ACGO
AB.74.033



O_2 / Air
225
145
144
149
Venturi Drive
Suction
150
146
148
AB.91.012

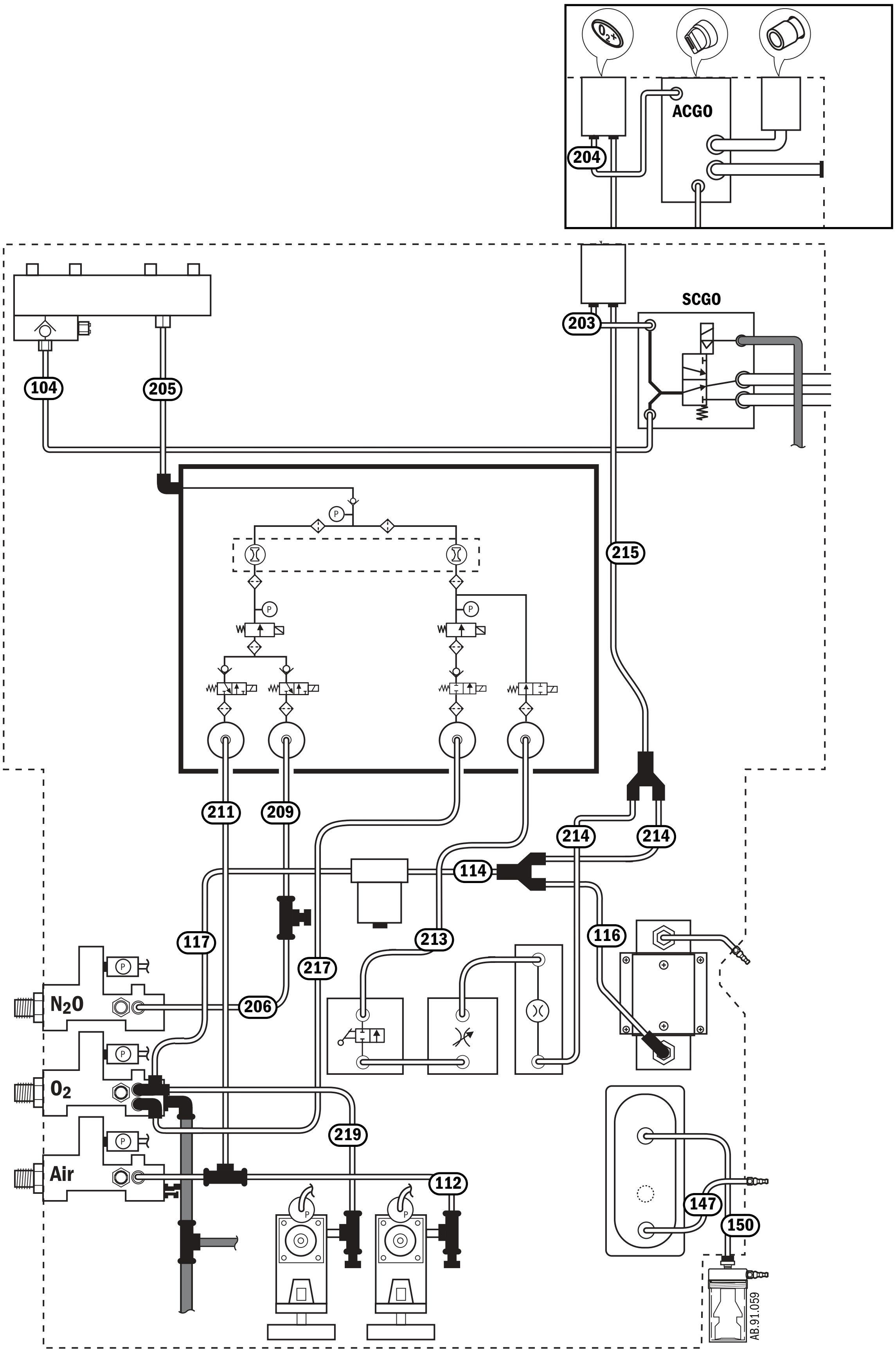
10.32 Tubing for use with Legris fittings

Except for the Tygon tubing (Items 147 and 150), this tubing is a flexible, Nylon-type tubing for use with quick-release fittings.

Item	Description	Length — Size	Stock Number
	Tube Markings (factory build only)		
206	N20 PLINE	230 mm - 4 mm	1001-3060-000
208*	N20 CYL	330 mm - 4 mm	1001-3060-000
209	N2O PLINE - MIXER	430 mm - 4 mm	1001-3060-000
114	REGULATED O2	400 mm - 6 mm	1001-3062-000
116	AUX O2	250 mm - 6 mm	1001-3062-000
117	O2 PLINE - REG IN	330 mm - 6 mm	1001-3062-000
123**	unmarked	175 mm - 6 mm	1001-3062-000
213	REGULATED O2	560 mm - 6 mm	1001-3062-000
214	REGULATED O2	270 mm - 6 mm	1001-3062-000
215	REGULATED O2	300 mm - 6 mm	1001-3062-000
217	O2 PLINE - MIXER	580 mm - 6 mm	1001-3062-000
219	O2 CYL - O2 PLINE	215 mm - 6 mm	1001-3062-000
112	AIR CYL- AIR PLINE	270 mm - 8 mm	1001-3063-000
211	AIR PLINE - MIXER	460 mm - 8 mm	1001-3063-000
104	VAP OUT- ACGO	840 mm - 1/4 inch	1001-3064-000
147	unmarked (Tygon)	290 mm - 1/2 inch	6700-0005-300
150	unmarked (Tygon)	180 mm - 1/2 inch	6700-0005-300
203	FLUSH VLV-SCGO	110 mm - 1/4 inch	1001-3064-000
204	FLUSH VLV-ACGO	125 mm - 1/4 inch	1001-3064-000
205	MIXER - VAP IN	600 mm - 1/4 inch	1001-3064-000

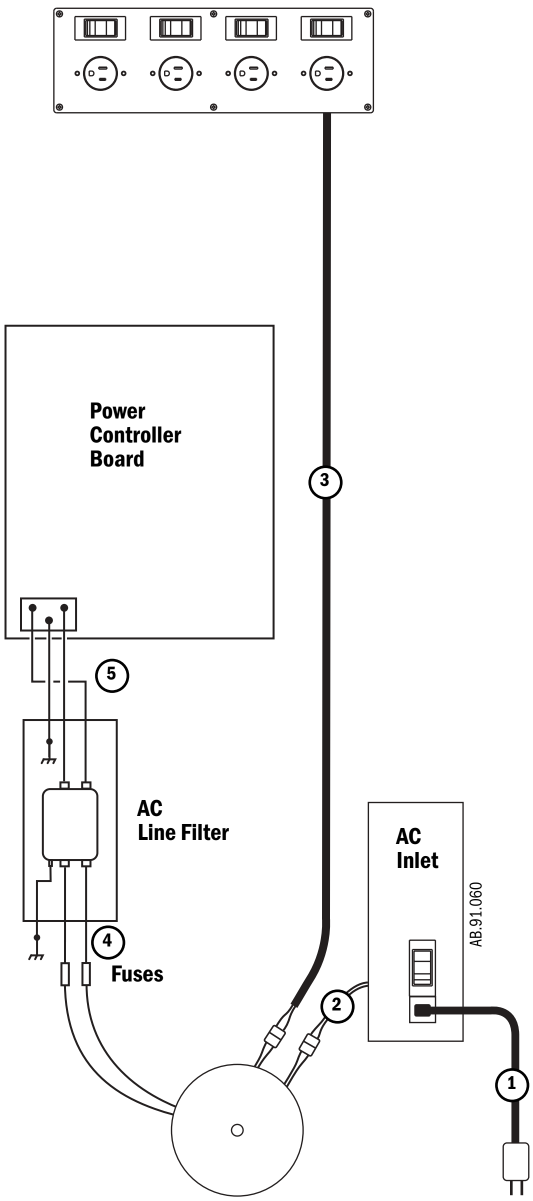
* With an N_2O cylinder supply, Item 208 connects the N_2O cylinder supply to the Tee connector between Items 206 and 209.

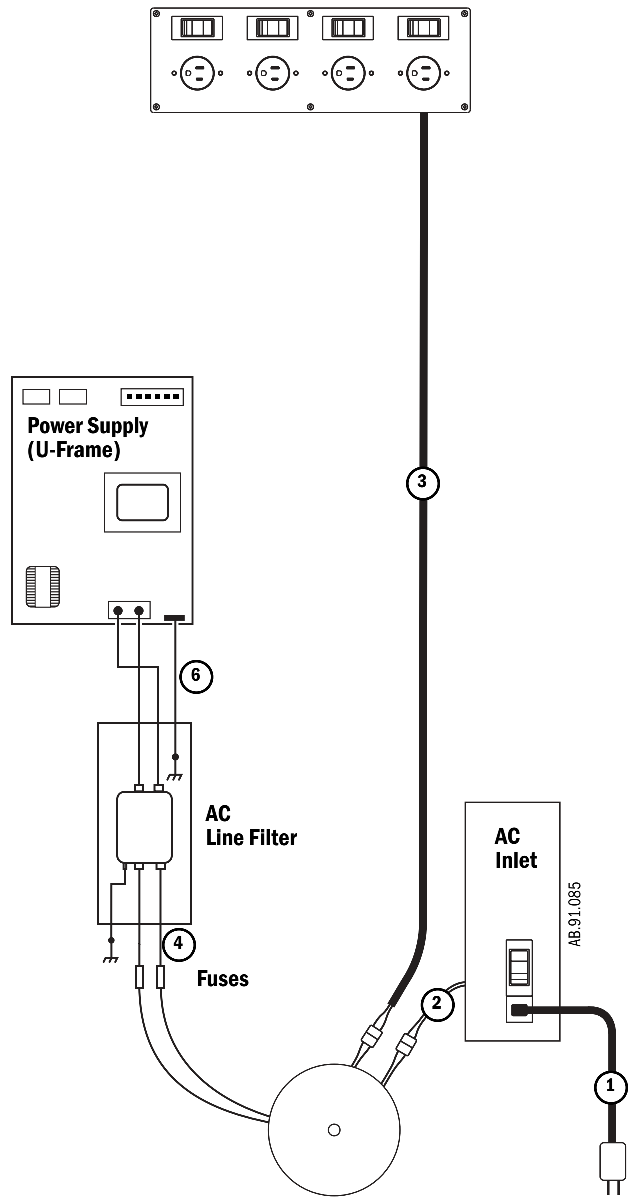
** With two inboard O_2 cylinder supplies, Item 123 connects the second O_2 cylinder supply to the first O_2 cylinder supply.


ACGO
204
SCGO
203
104
205
215
211
209
214
214
114
117
116
213
217
N2O
206
O2
219
Air
112
147
150
AB.91.059

10.33 Cables and harnesses (power supply)

Item	Description	Stock Number
1	Power Cord	Refer to section 10.5
2	Harness, 100/120 V to Toroid	1009-5752-000
	Harness, 220/240 V to Toroid	1009-5753-000
3	Harness, to 100/120 V outlets	1009-5716-000
	Harness, to 220/240 V outlets	1009-5717-000
4	Harness, fuse block to AC line filter	1009-5754-000
5	Harness, AC line filter to Power Controller Board	1009-5751-000
6	Harness, AC line filter to Power Supply (U-Frame)	M1052276

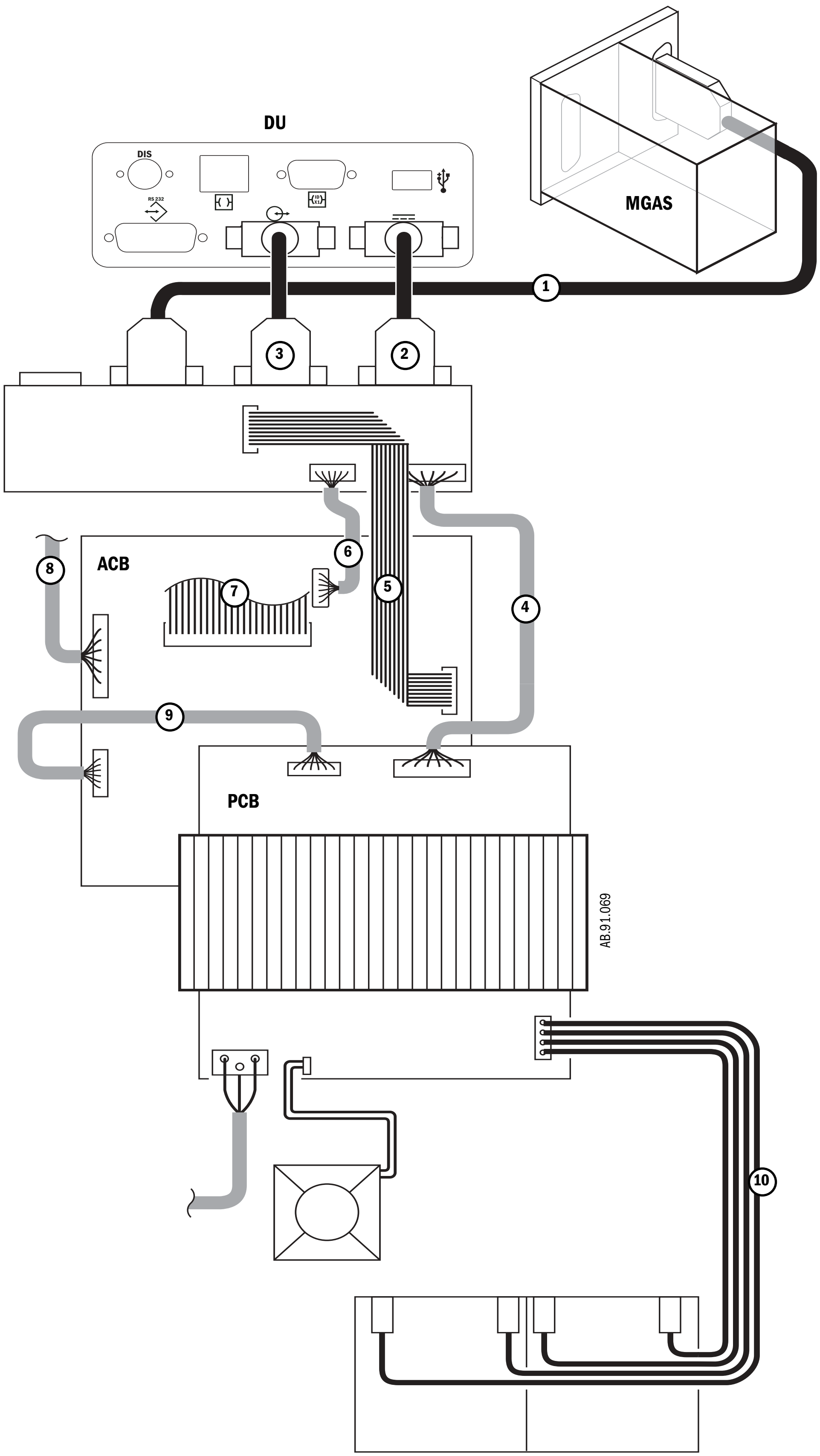

Power
Controller
Board
3
5
AC
Line Filter
AC
Inlet
4
Fuses
2
1
AB.91.060


Power Supply
(U-Frame)
3
6
AC
Line Filter
AC
Inlet
4
Fuses
2
1
AB.91.085

10.34 Cables and harnesses in lower electronic enclosure

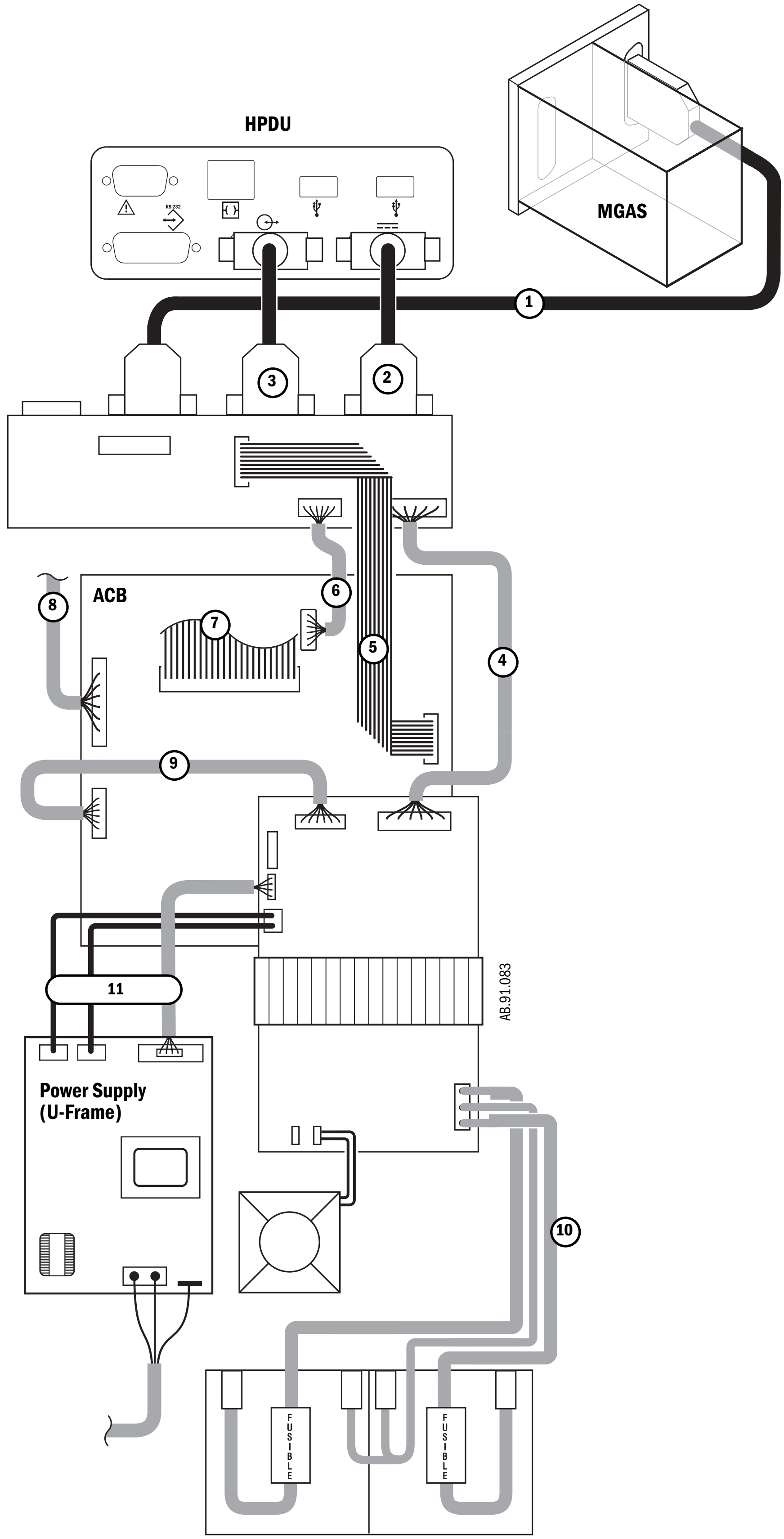
10.34.1 Machines with original Power Controller board

Item	Description	Stock Number
1	Cable, to MGAS (Airway module) power supply	1009-5555-000
2	Cable, to Display Unit system power interface	1009-5571-000
3	Cable, to Display Unit system signal interface	1009-5572-000
4	Harness, J3-PCB to J5-DCB	1009-5552-000
5	Cable, ribbon J2-ACB to J9-DCB	1009-5561-000
6	Harness, J7-ACB to J6-DCB	1009-5556-000
7	Cable, ribbon J1-ACB to underside of Pan Connector Board	1009-5549-000
8	Harness, J3-ACB to underside of Pan Connector Board	1009-5560-000
9	Harness, J4-ACB to J4-PCB	1009-5551-000
10	Harness, battery	1009-5557-000


DU
DIS
RS 232
MGAS
1
2
3
4
5
6
7
8
9
ACB
PCB
AB.91.069
10

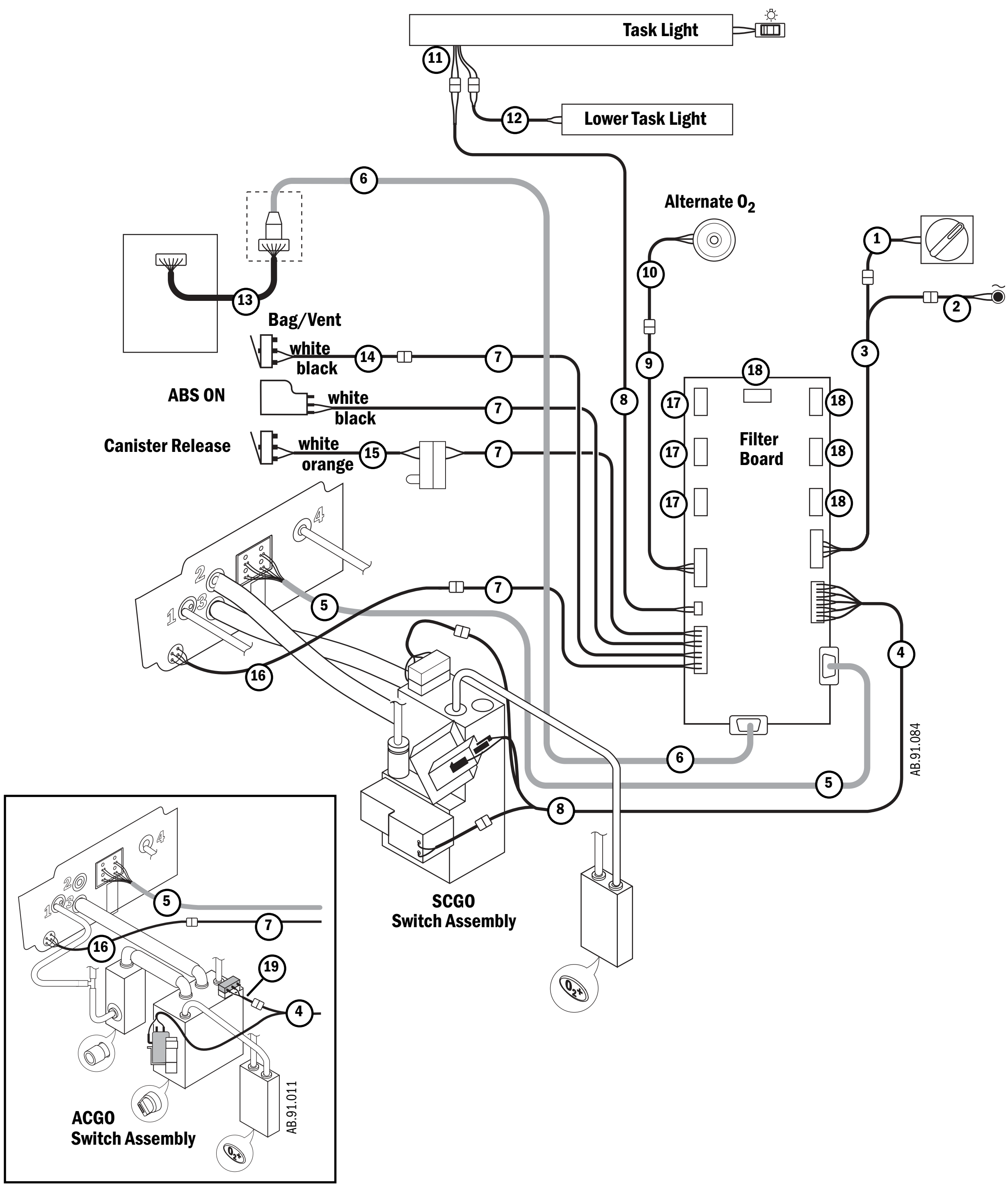
10.34.2 Machines with Universal Power Supply (U-Frame)

Item	Description	Stock Number
1	Cable, to MGAS (Airway module) power supply	1009-5555-000
2	Cable, to Display Unit system power interface	1009-5571-000
3	Cable, to Display Unit system signal interface	1009-5572-000
4	Harness, J3-PCB to J5-DCB	1009-5552-000
5	Cable, ribbon J2-ACB to J9-DCB	1009-5561-000
6	Harness, J7-ACB to J6-DCB	1009-5556-000
7	Cable, ribbon J1-ACB to underside of Pan Connector Board	1009-5549-000
8	Harness, J3-ACB to underside of Pan Connector Board	1009-5560-000
9	Harness, J4-ACB to J4-PCB	1009-5551-000
10	Harness, (flex-cable) battery	M1049280
11	Harness, Power Supply to PCB	M1049276


HPDU
RS 232
MGAS
1
2
3
4
5
6
7
8
9
10
11
ACB
Power Supply
(U-Frame)
FUSIBLE
FUSIBLE
AB.91.083

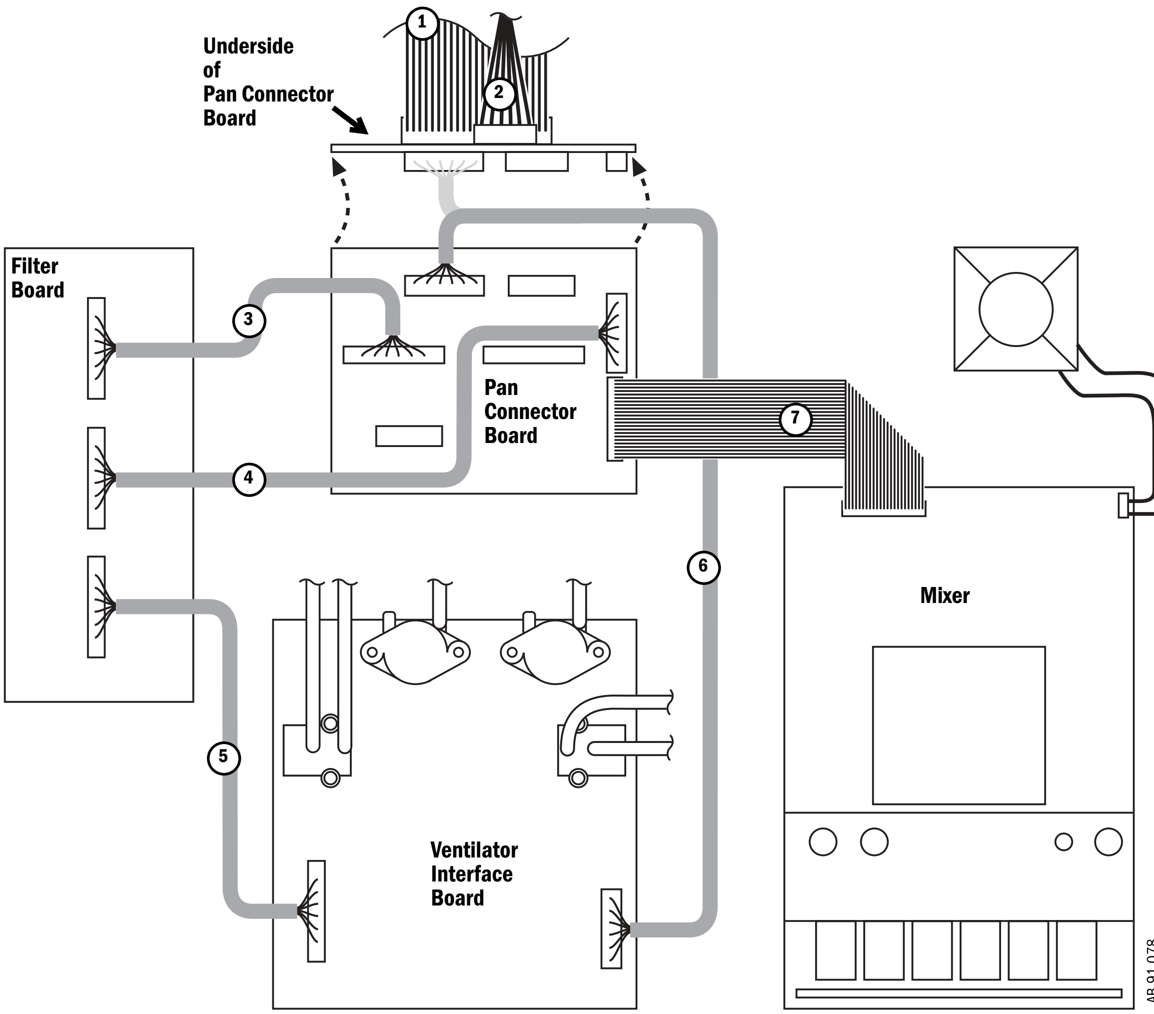
10.35 Cables and harnesses (Filter Board interface)

Item	Description	Stock Number
1	Harness, On/Standby system switch	1009-5542-000
2	LED assembly, mains green	1009-5514-000
3	Harness, Filter Board to On/Standby switch and LED	1009-5538-000
4	Harness, Filter Board to SCGO/ACGO	1009-5528-000
5	Harness, Filter Board to ABS flow sensors (includes tubing)	1009-8223-000
6	Cable, Filter Board to Vent Engine harness connector	1009-5521-000
7	Harness, Filter Board to O_2 Cell and ABS switches	1009-5531-000
8	Harness, Filter Board to Task Lights	1009-5533-000
9	Harness, Filter Board to Alternate O_2 switch	1009-5532-000
10	Switch, Alt O_2 (includes harness)	1009-5517-000
11	Harness, Task Light	1009-5853-000
12	Harness, Lower Task Light	1009-5854-000
13	Harness, Vent Engine Board	1009-5545-000
14	Harness, Bag/Vent switch to Filter Board harness	1009-5585-000
15	Harness, Canister Release switch (CO_2 Bypass)	1407-3144-000
16	Harness, O_2 Cell to Filter Board harness	1009-5586-000
17	Transducer, pipeline pressure (includes cable)	1011-3000-000
18	Transducer, cylinder pressure (includes cable)	1011-3001-000
19	Harness, ACGO switch to Filter Board harness	1009-5872-000


Task Light
11
12
Lower Task Light
6
13
Alternate O2
1
10
2
Bag/Vent
white
black
14
7
ABS ON
white
black
7
8
9
3
18
17
18
Filter
Board
Canister Release
white
orange
15
7
17
18
17
18
5
7
4
16
6
5
8
AB.91.084
SCGO
Switch Assembly
5
7
16
19
4
ACGO
Switch Assembly
AB.91.011

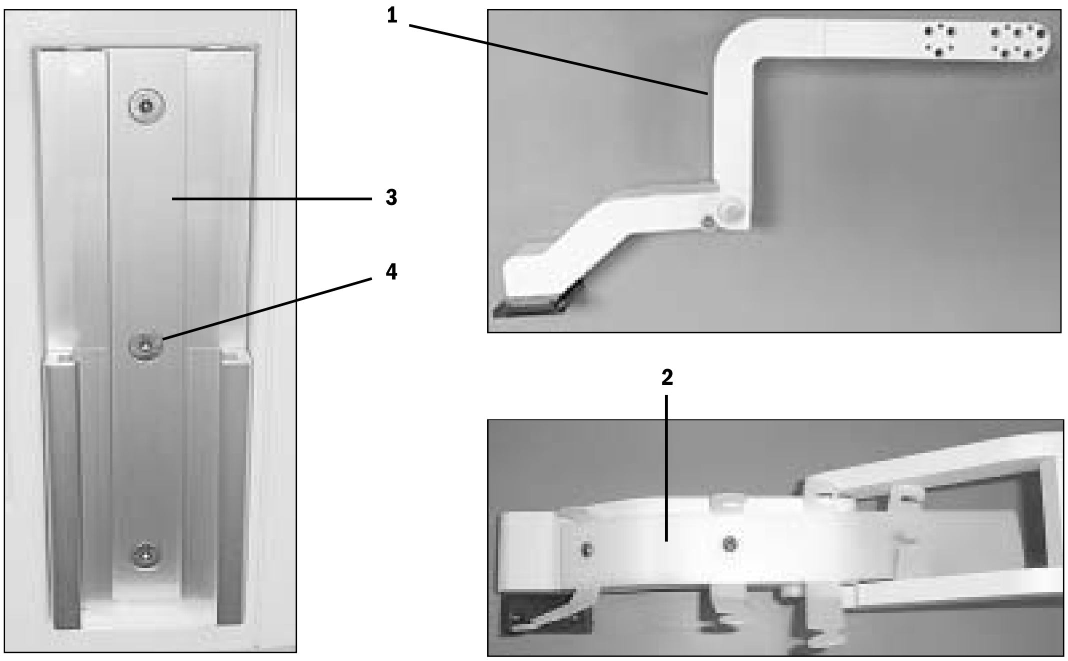
10.36 Cables and harnesses in Pan enclosure

Item	Description	Stock Number
1	Cable, ribbon J1-ACB to underside of Pan Connector board	1009-5549-000
2	Harness, J3-ACB to underside of Pan Connector board	1009-5560-000
3	Harness, Pan Connector board to Filter board, 24 POSN	1009-5544-000
4	Harness, Pan Connector board to Filter board, 12 POSN	1009-5543-000
5	Harness, Filter board to VIB	1009-5546-000
6	Harness, Pan Connector board to VIB	1009-5547-000
7	Cable, ribbon, Pan Connector board to Mixer	1009-5550-000



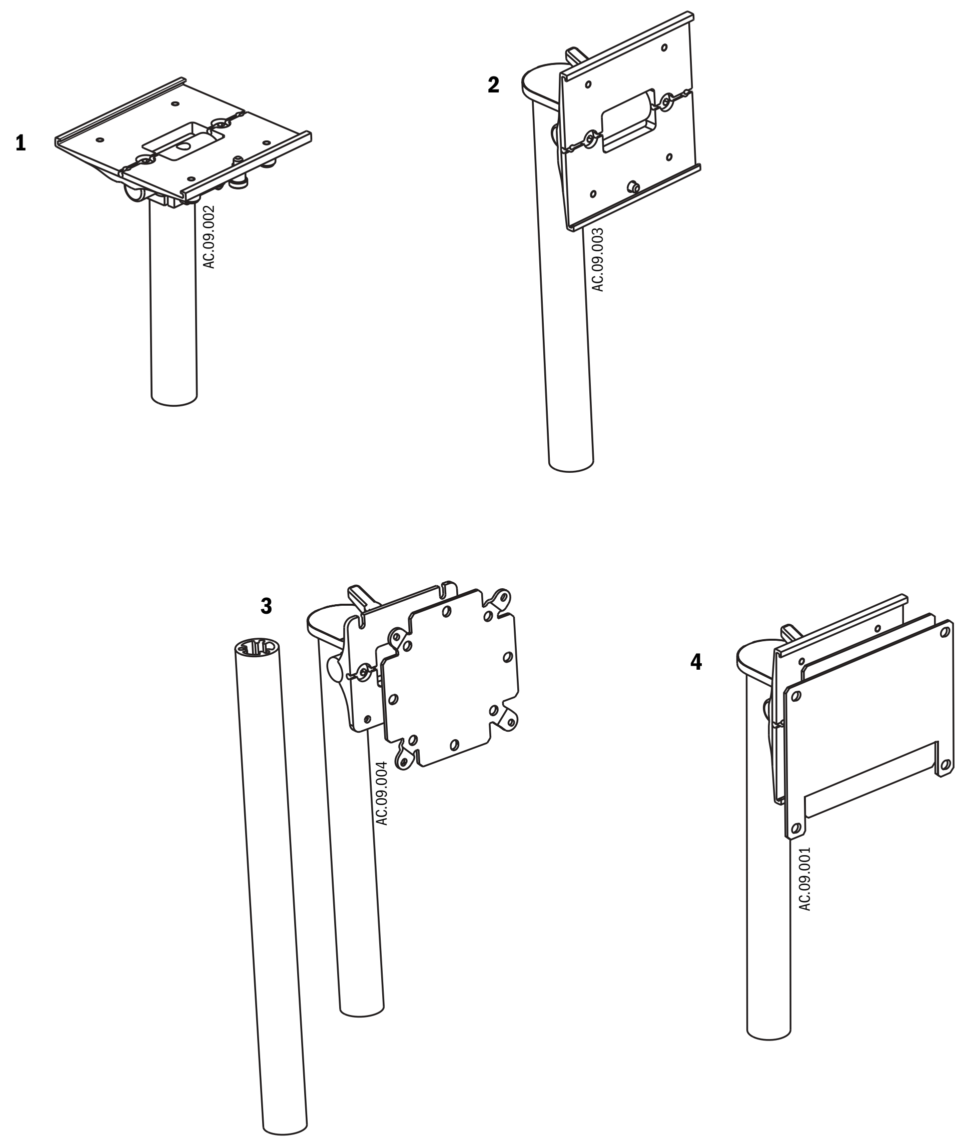
Underside
of
Pan Connector
Board
1
2
Filter
Board
3
4
5
Pan
Connector
Board
7
6
Mixer
Ventilator
Interface
Board
AB.91.078

10.37 Optional Monitor Display mounts



Item	Description	Stock Number
1	Arm (long), pivoting display mount	1009-3262-000
2	Cable Guide Kit, for long arm	1009-8473-000
3	Extrusion, upper dovetail	1009-3113-000
4	Screw, M6x20	0144-2131-925

10.38 Display arm mounting kits for optional equipment



Item	Description	Stock Number
1	Cardiocap 5 mount	1009-3265-000
2	S/5 Flat Panel mount	1009-3266-000
3	Spacelabs Flat Panel mount	1009-3267-000
4	Spacelabs PC Scout mount	1009-3268-000

Notes

11 Schematics and Diagrams

In this section

Schematics are subject to change without notice.

Circuit boards are available only as complete assemblies.

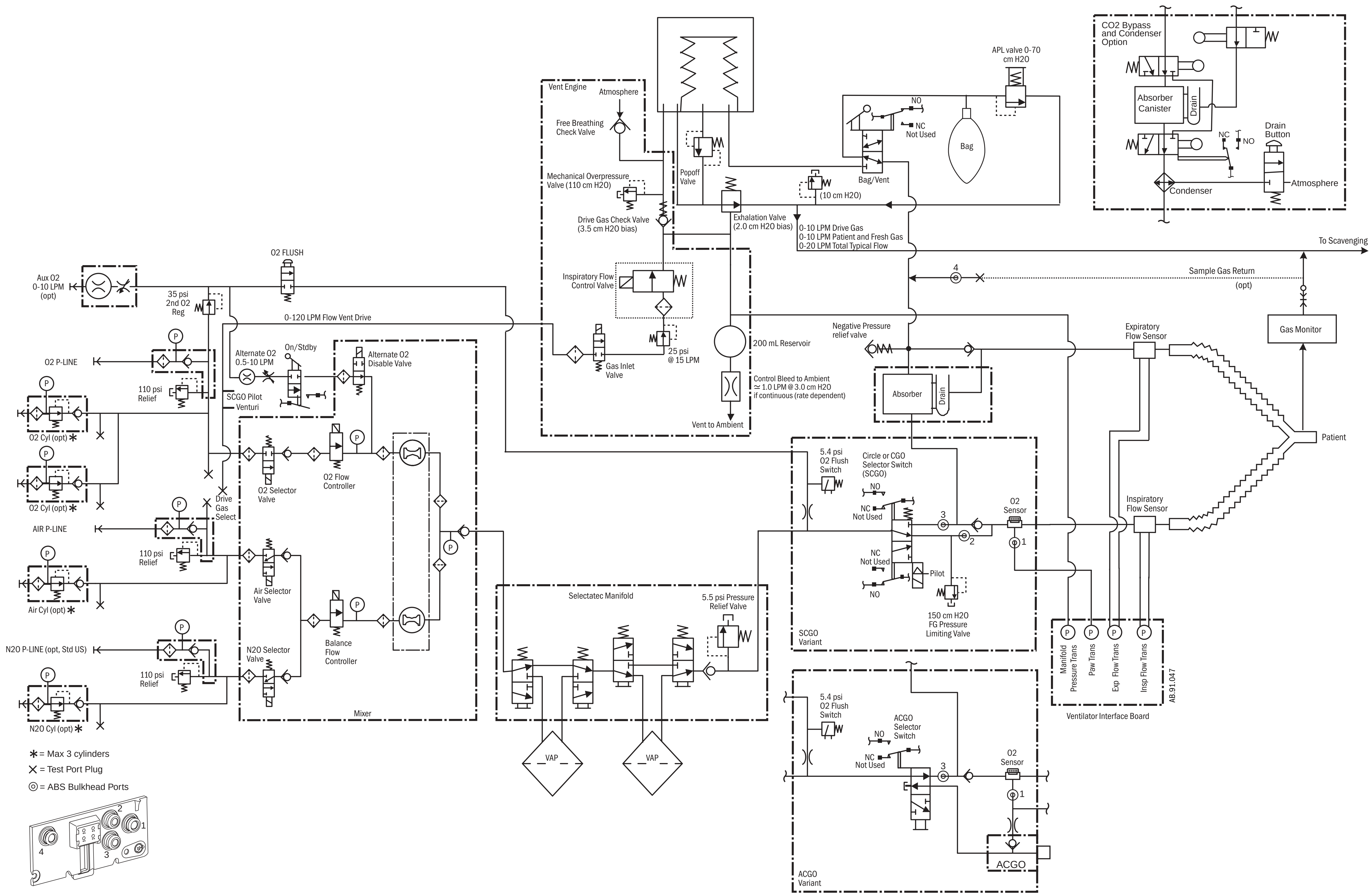
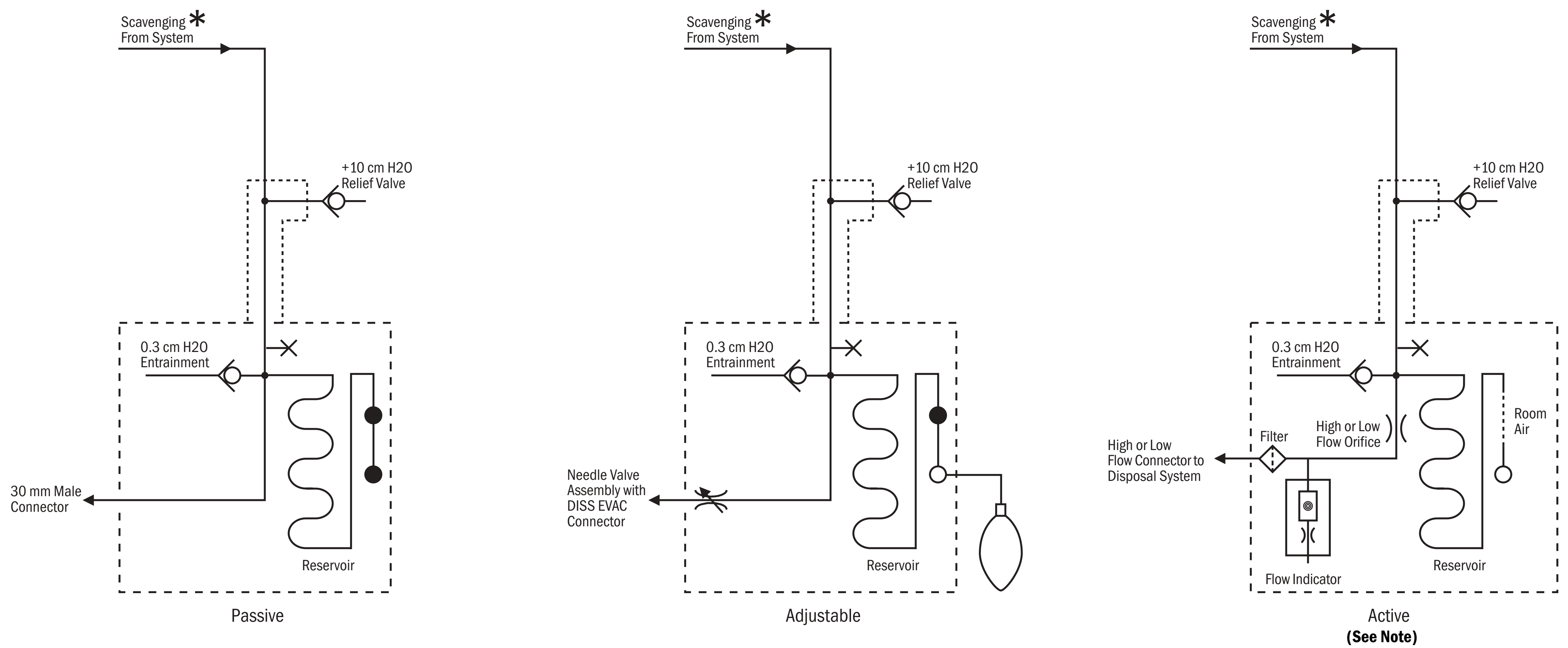


Figure 11-1 • System circuit diagram



Key to Symbols

- ✕ = Plugged port (1/8 inch) for sample gas return.
- ● = Plugged port (30 mm) for auxiliary breathing system scavenging.
- ○ = Open port (30 mm) for auxiliary breathing system scavenging.
- * = Zero to 10 l/min drive gas; zero to 10 l/min patient and fresh gas; zero to 20 l/min total typical flow.

Note: Active AGSS systems with a 12.7 mm connector do not include the Flow Orifice and the Flow Indicator.

Figure 11-2 • Gas scavenging circuits

Key to Numbered Components

1. Pipeline inlet
2. Pipeline pressure transducer
3. High-pressure relief valve (758 kPa / 110 psi)*
4. Supply connections for the ventilator and pilot pressure for SCGO
   a. O_2 drive gas
   b. Air drive gas
5. Venturi suction supply connection
   a. O_2 drive gas
   b. Air drive gas
6. Cylinder inlet
7. Cylinder pressure transducer
8. Primary regulator (cylinder pressure)
9. Test port (primary regulator)
10. System switch
11. Selector valve
    a = O_2; b = Air; c = N_2O
12. Flow controller
    a = O_2; b = balance gas
13. Alternate O_2 disable valve
14. Hot-wire anemometer
    a = O_2 flow sensor channel; b = balance gas flow sensor channel
15. Vaporizer port valve
16. Vaporizer
17. Low-pressure relief valve (38 kPa / 5.5 psi)*
18. O_2 flush and auxiliary flowmeter regulator (241 kPa / 35 psi)*
19. O_2 Flush valve
20. Pressure switch (used with the ventilator)
21. Breathing system pressure relief valve (SCGO only — 150 cmH_2O)*
22. To Port 3 of ABS interface (circle)
23. For SCGO, to Port 2 of ABS interface (non-circle Inspiratory port)
    For ACGO, to external 22-mm ACGO connector
24. Auxiliary O_2 flowmeter (optional)

* Approximate values

Key to Symbols

Pneumatic Connection

Filter

Direction of Flow

Check Valve

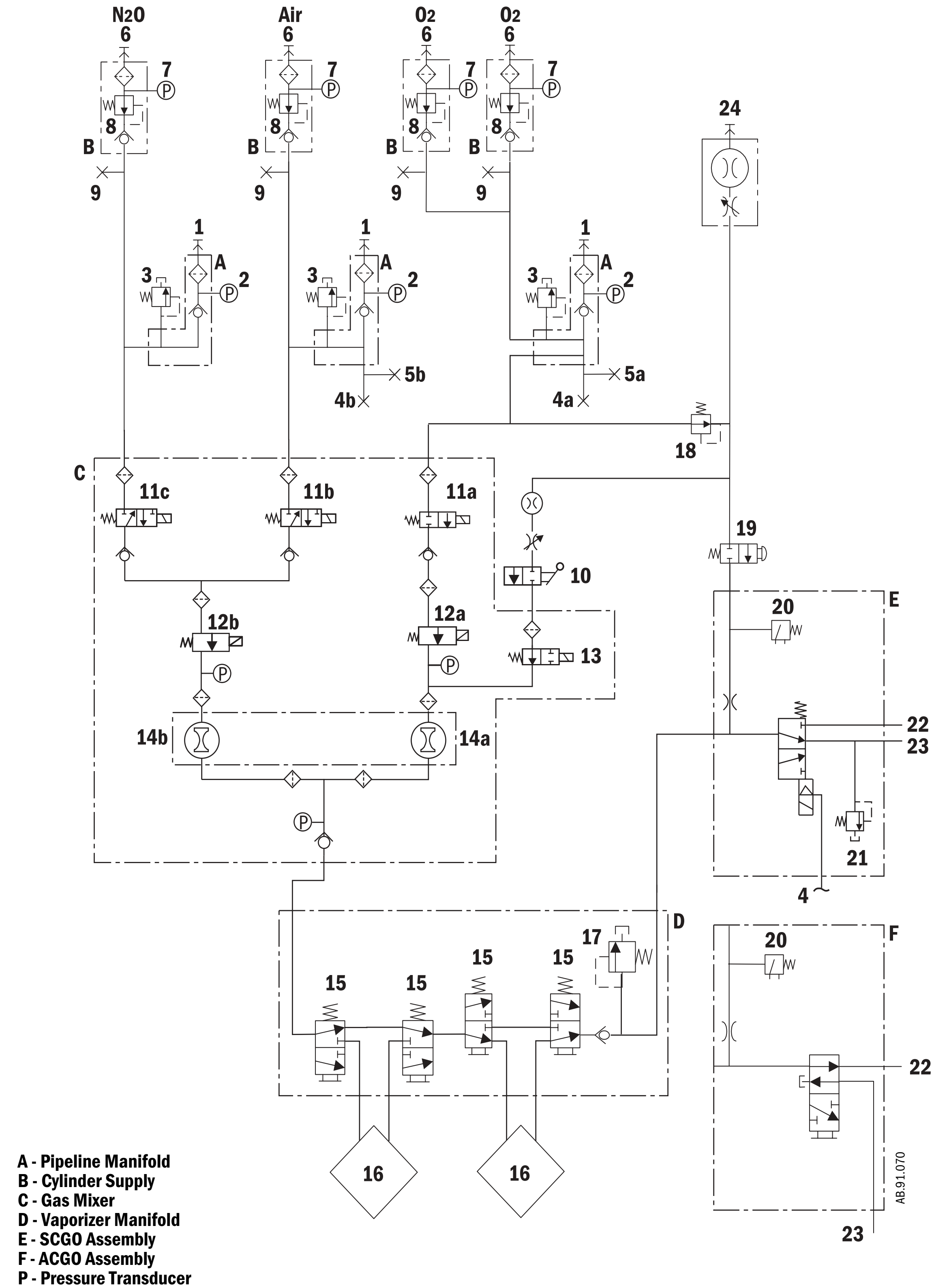


Figure 11-3 • Pneumatic circuit diagram

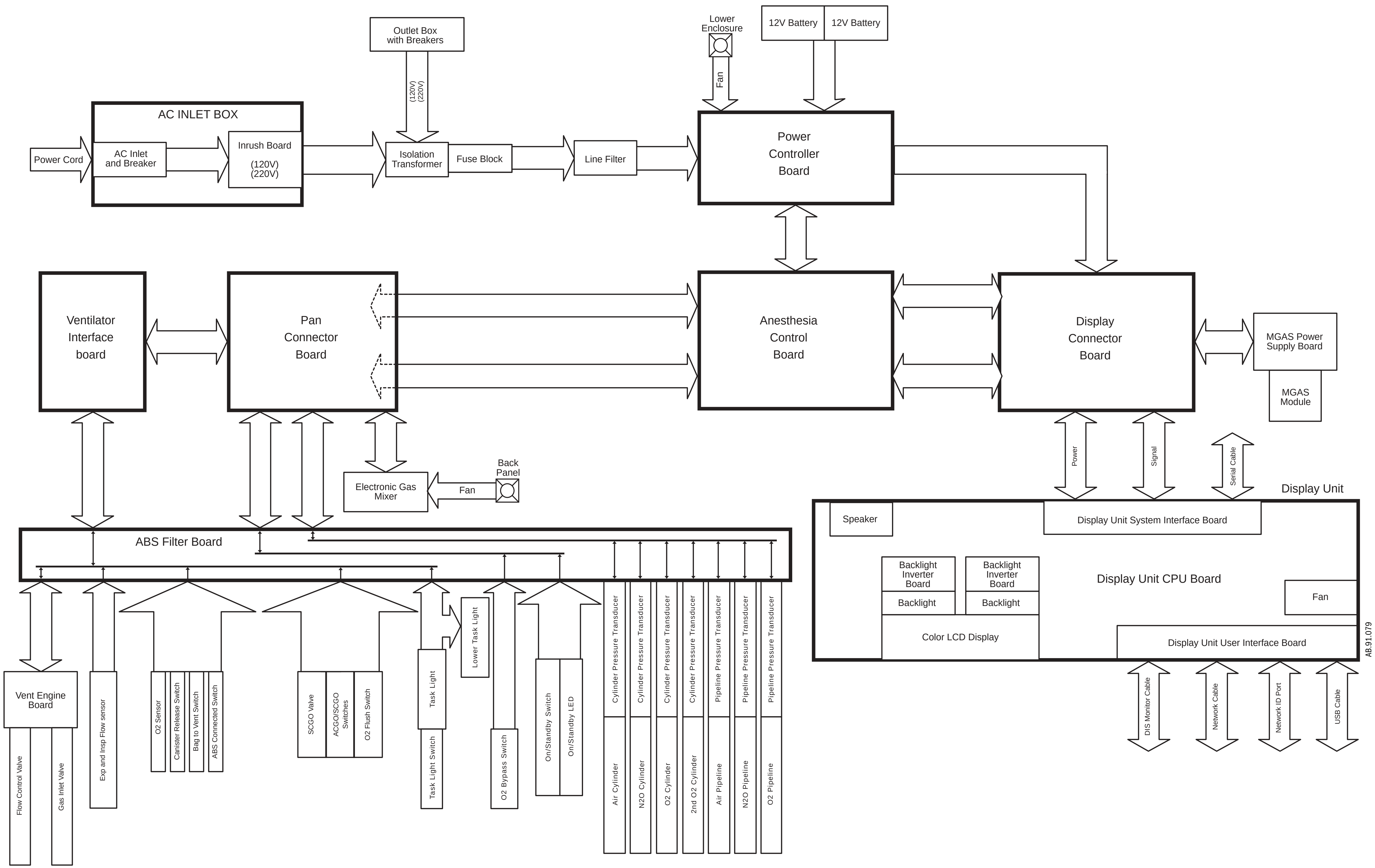


Figure 11-4 • Cabling block diagram

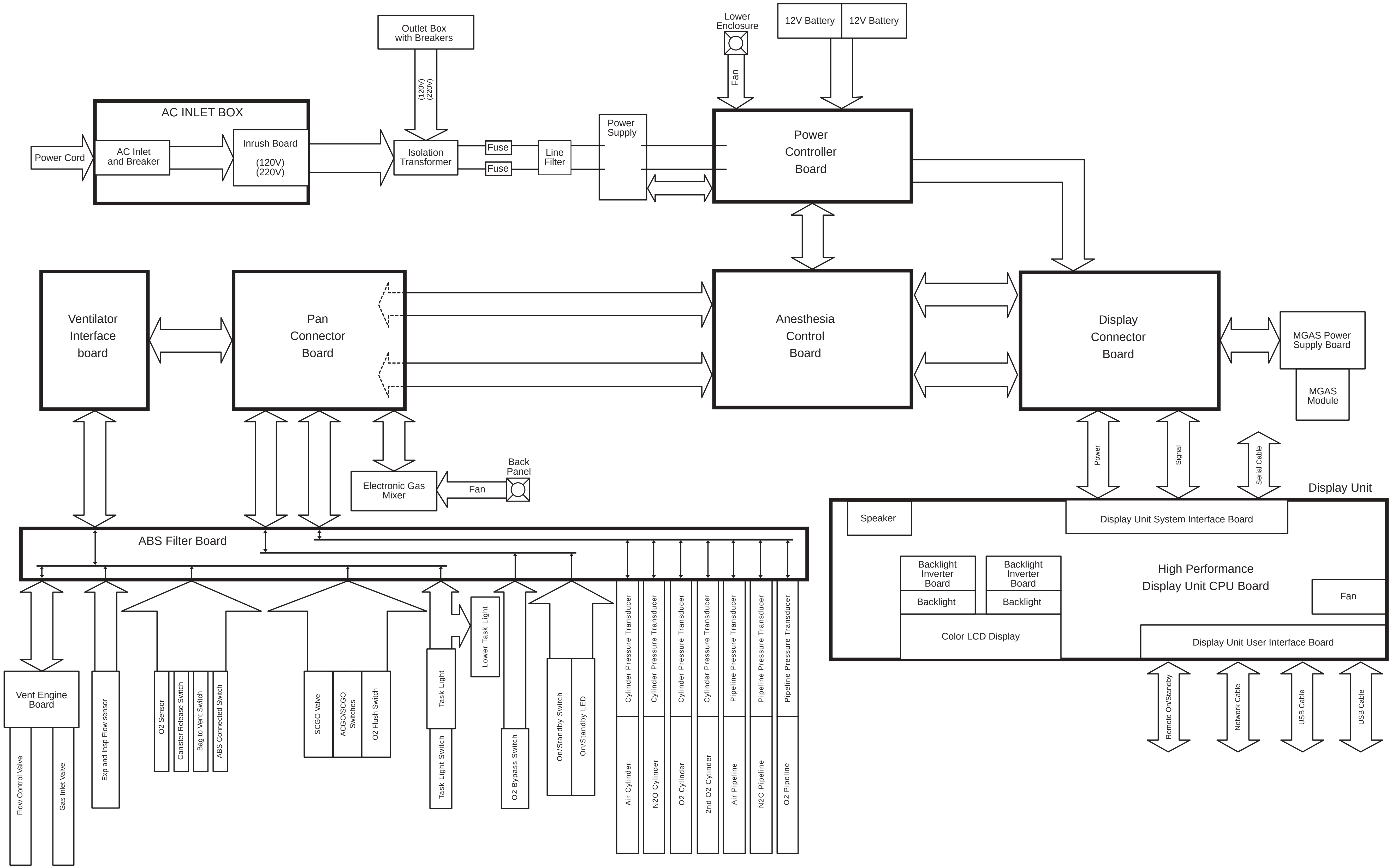


Figure 11-5 • Cabling block diagram (U-Frame and HPDU)

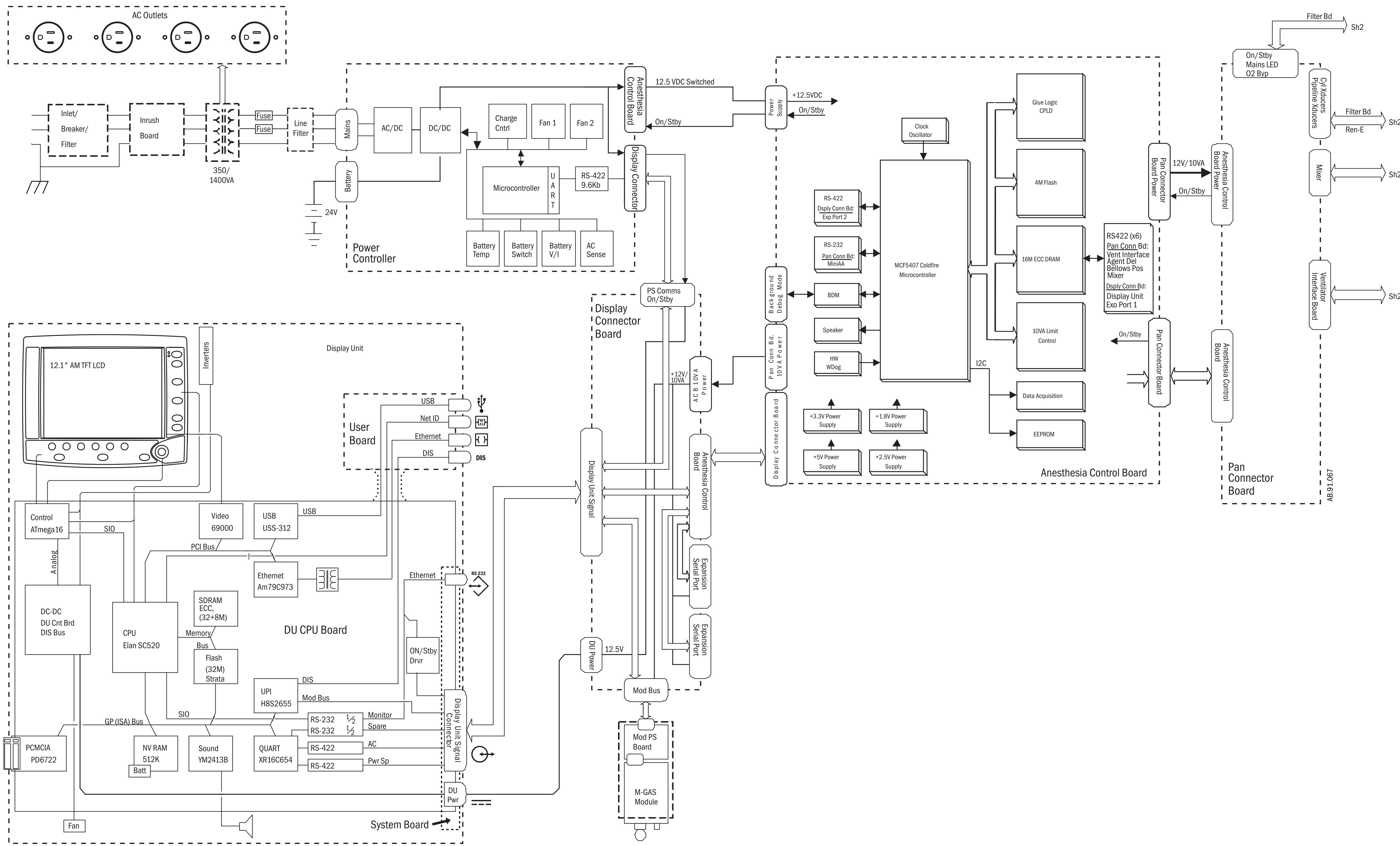


Figure 11-6 • System block diagram - original DU and Power Controller (sheet 1a of 2)

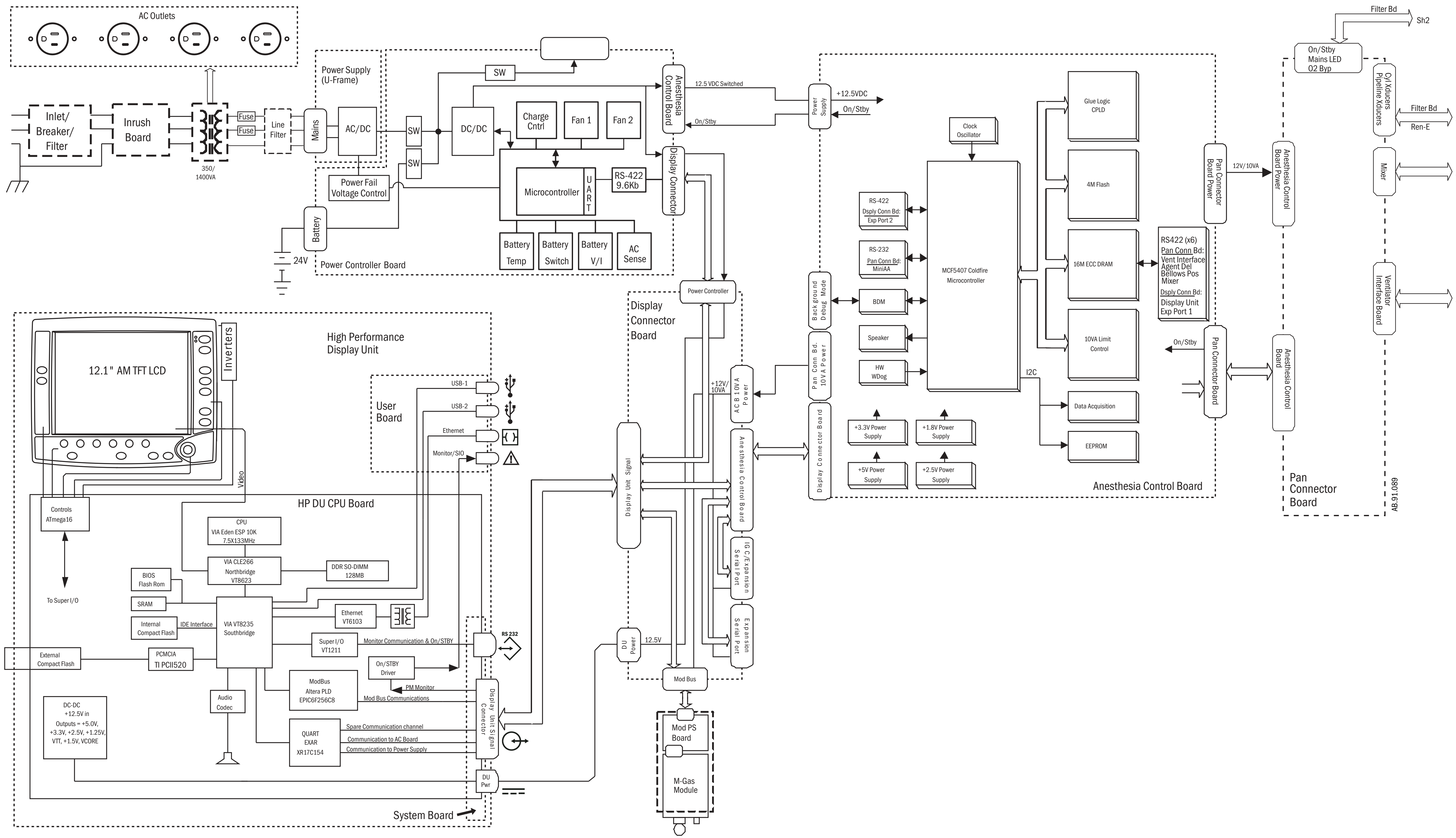


Figure 11-7 • System block diagram - with HPDU and U-Frame PCB (sheet 1b of 2)

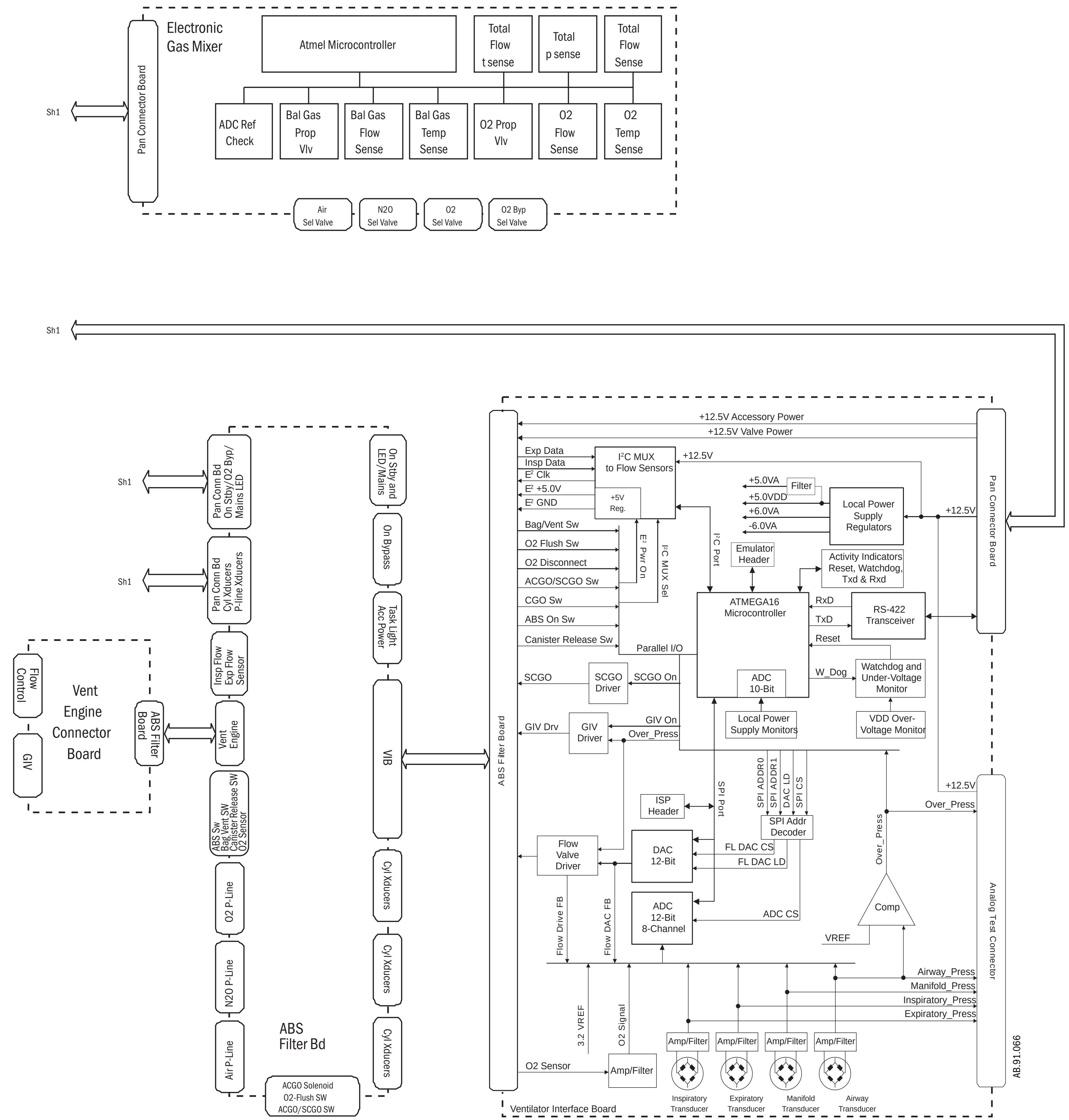
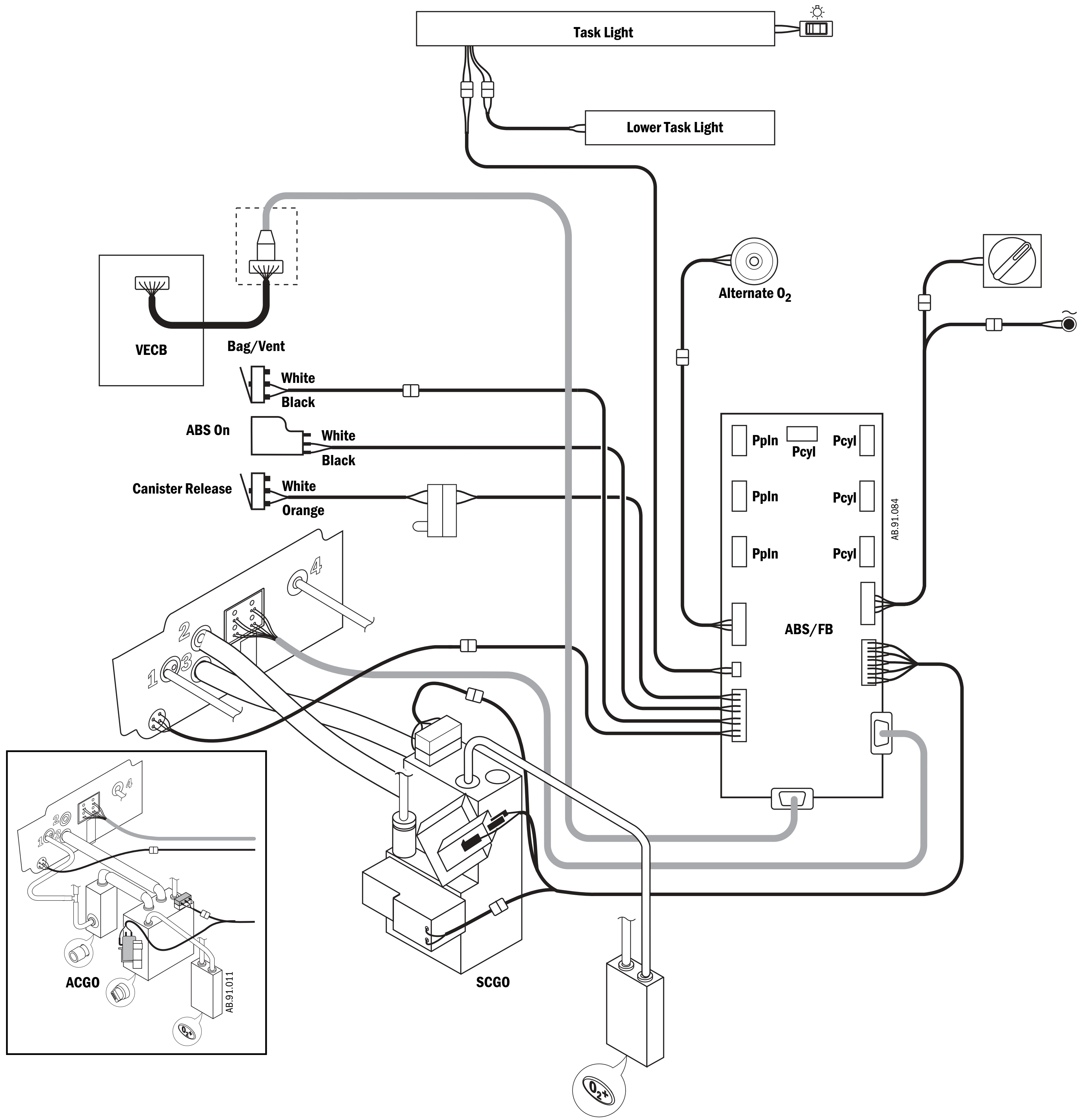


Figure 11-8 • System block diagram (sheet 2 of 2)



Key to Symbols

ABS/FB = ABS/Filter Board

PCB = Power Controller Board

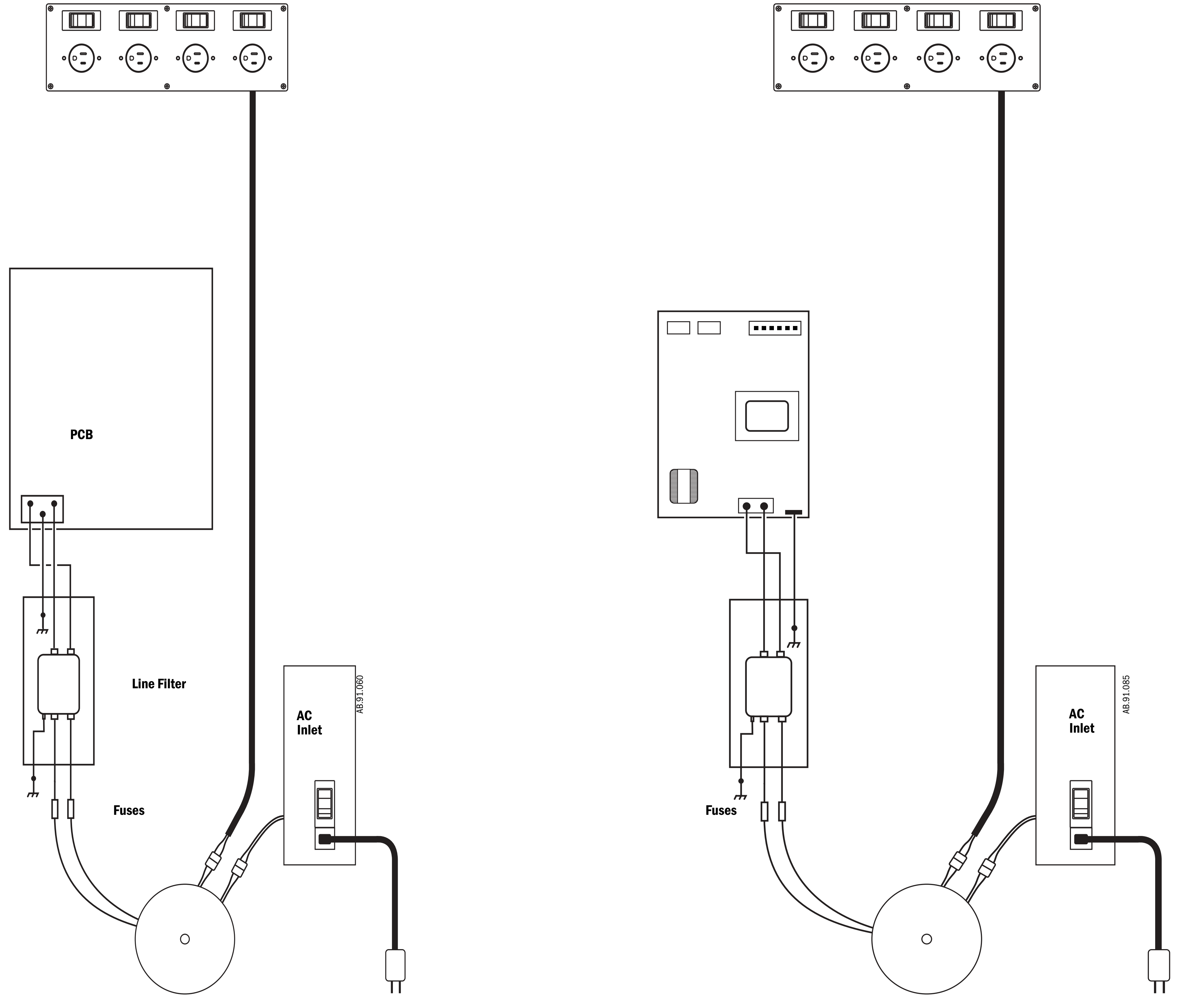
SCGO = Switched Common Gas Outlet

VECB = Vent Engine Connector Board

PpIn = Pressure Transducer Pipeline

Pcyl = Pressure Transducer Cylinder

Figure 11-9 • Wiring harnesses (1 of 2)



Key to Symbols

ABS/FB = ABS/Filter Board

PCB = Power Controller Board

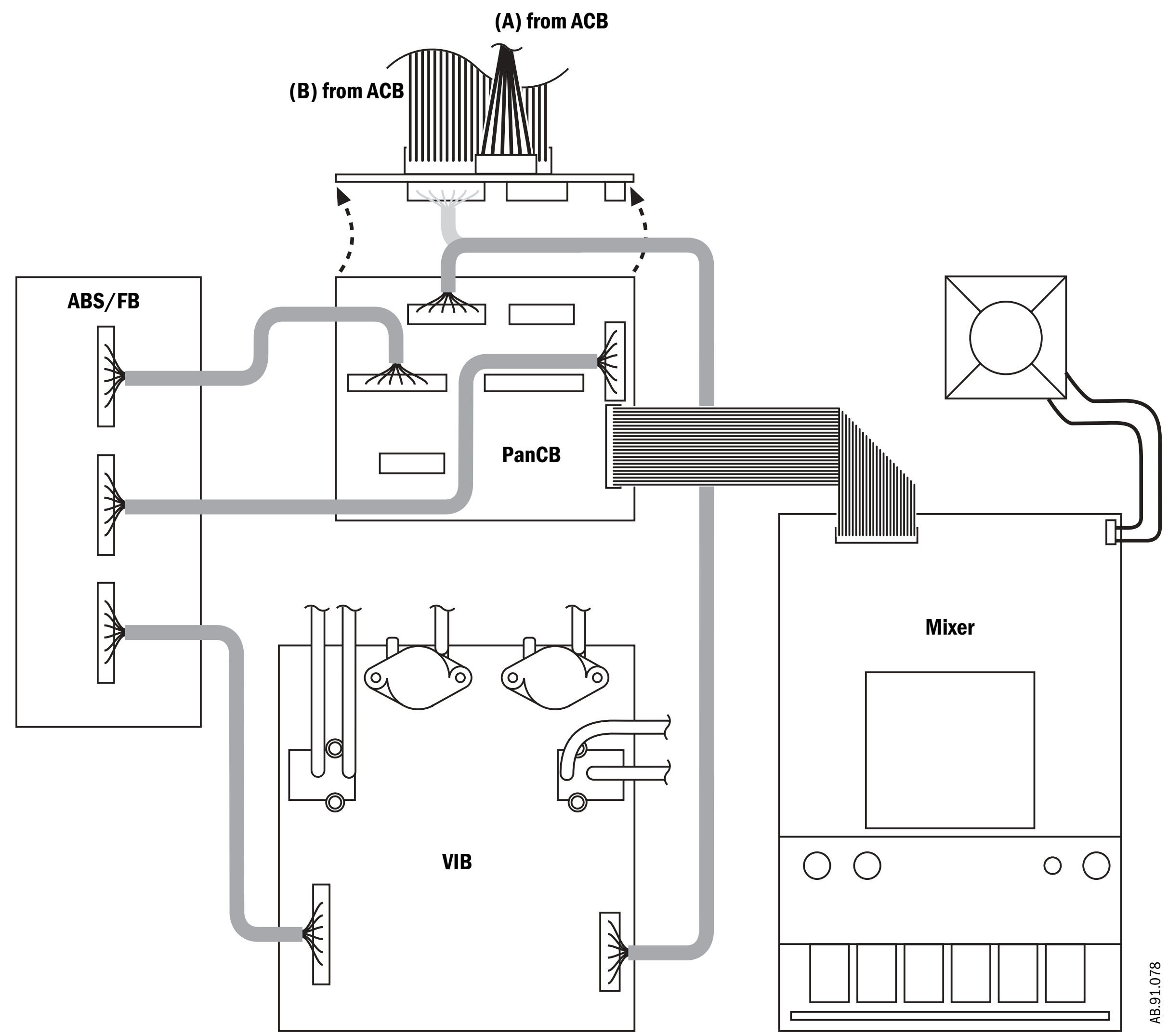
SCGO = Switched Common Gas Outlet

VECB = Vent Engine Connector Board

PpIn = Pressure Transducer Pipeline

Pcyl = Pressure Transducer Cylinder

Figure 11-10 • Wiring harnesses (2 of 2)



Key to Symbols

ABS/FB = ABS/Filter Board

ACB = Anesthesia Control board

DCB = Display Connector board

DU = Display Unit

MGAS = Compact Airway Module

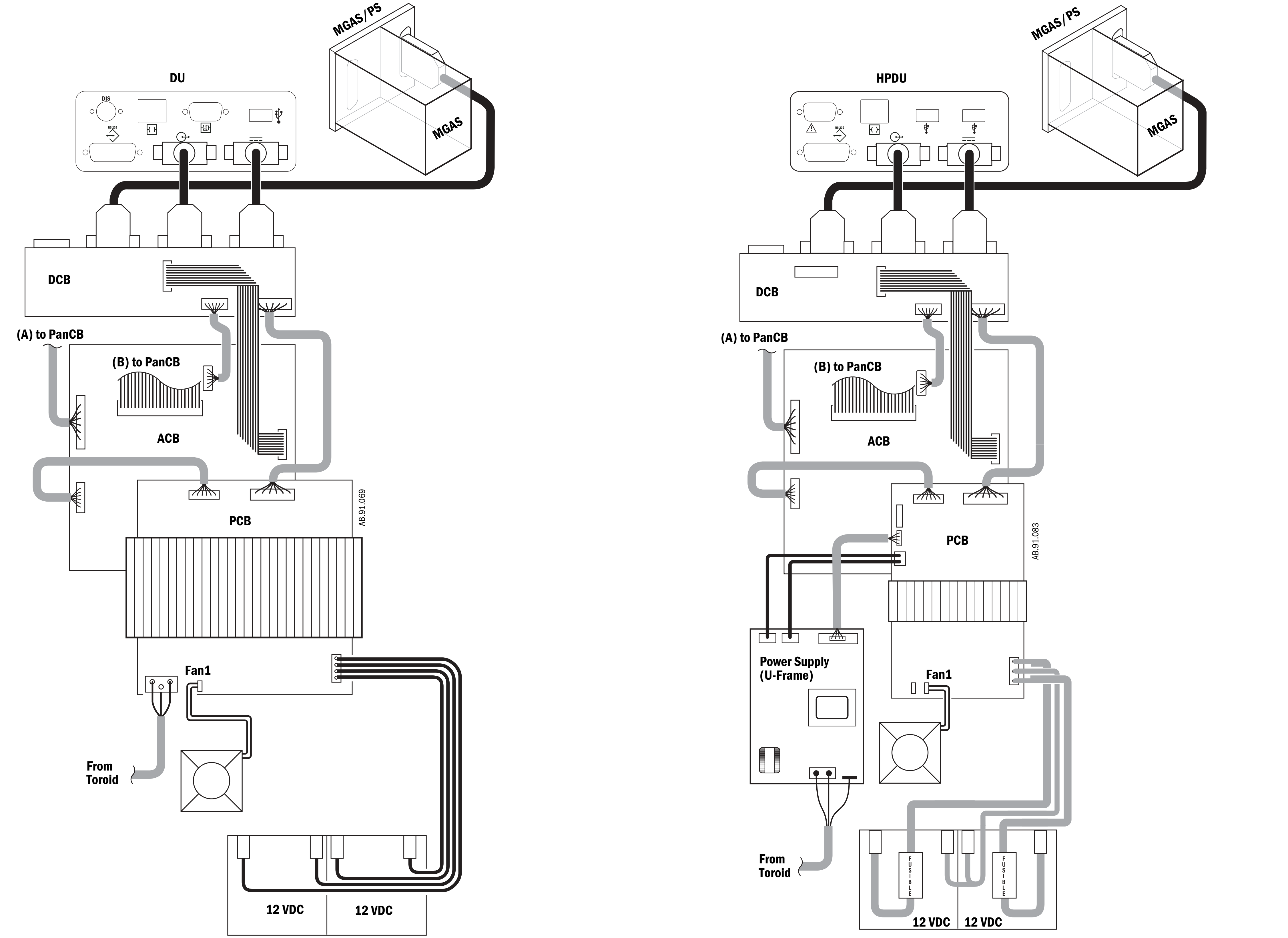
MGAS/PS = MGAS Power Supply

PanCB = Pan Connector board

PCB = Power Controller board

VIB = Ventilator Interface Board

Figure 11-11 ▪ Electrical cabling block diagram (Pan Enclosure)



Key to Symbols

ACB = Anesthesia Control board

DCB = Display Connector board

DU = Display Unit

HPDU = High Performance Display Unit

MGAS = Compact Airway Module

MGAS/PS = MGAS Power Supply

PanCB = Pan Connector board

PCB = Power Controller board

U-Frame = Universal Power Supply

Figure 11-12 • Electrical cabling (Lower Electrical Enclosure)

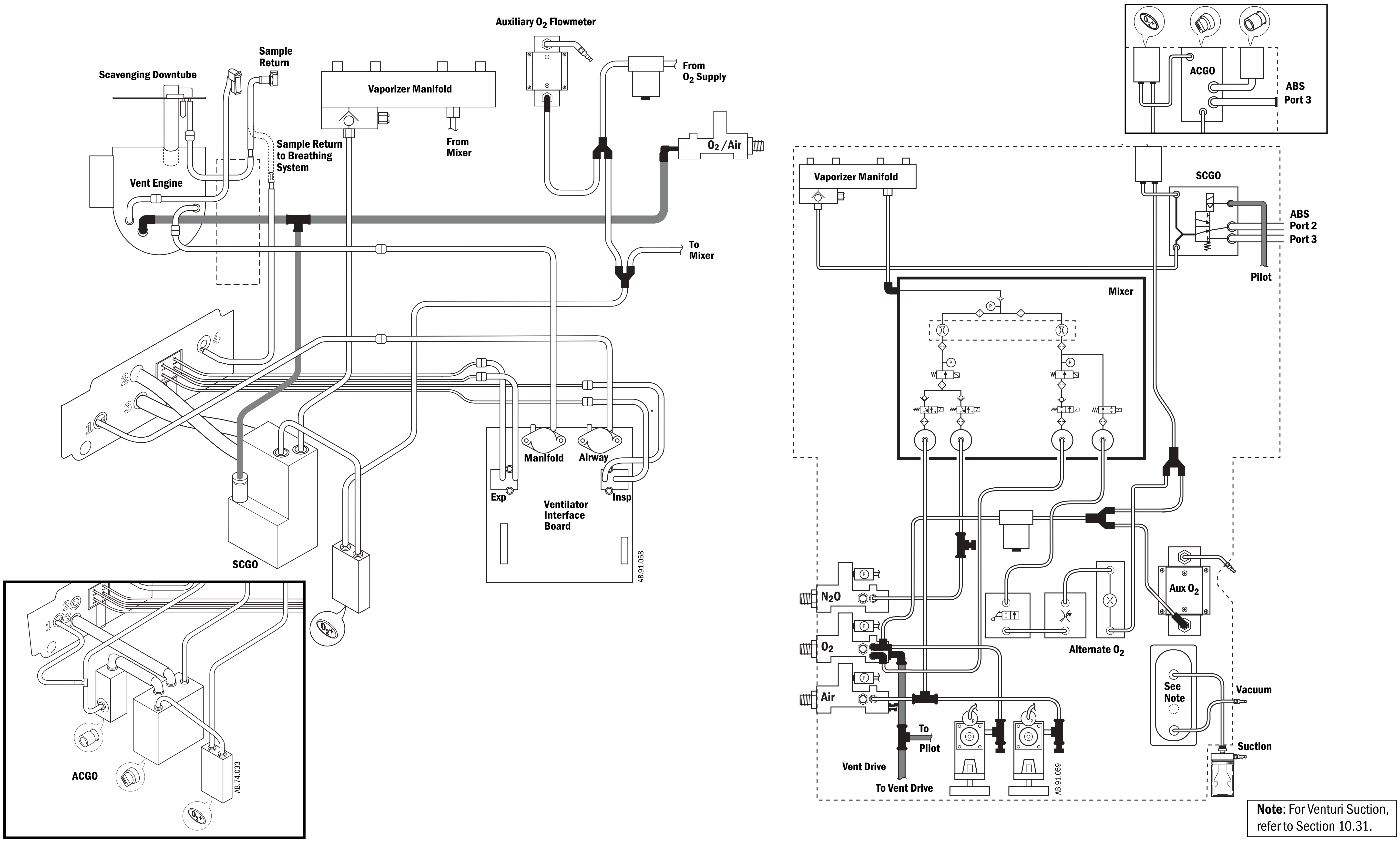


Figure 11-13 • Tubing

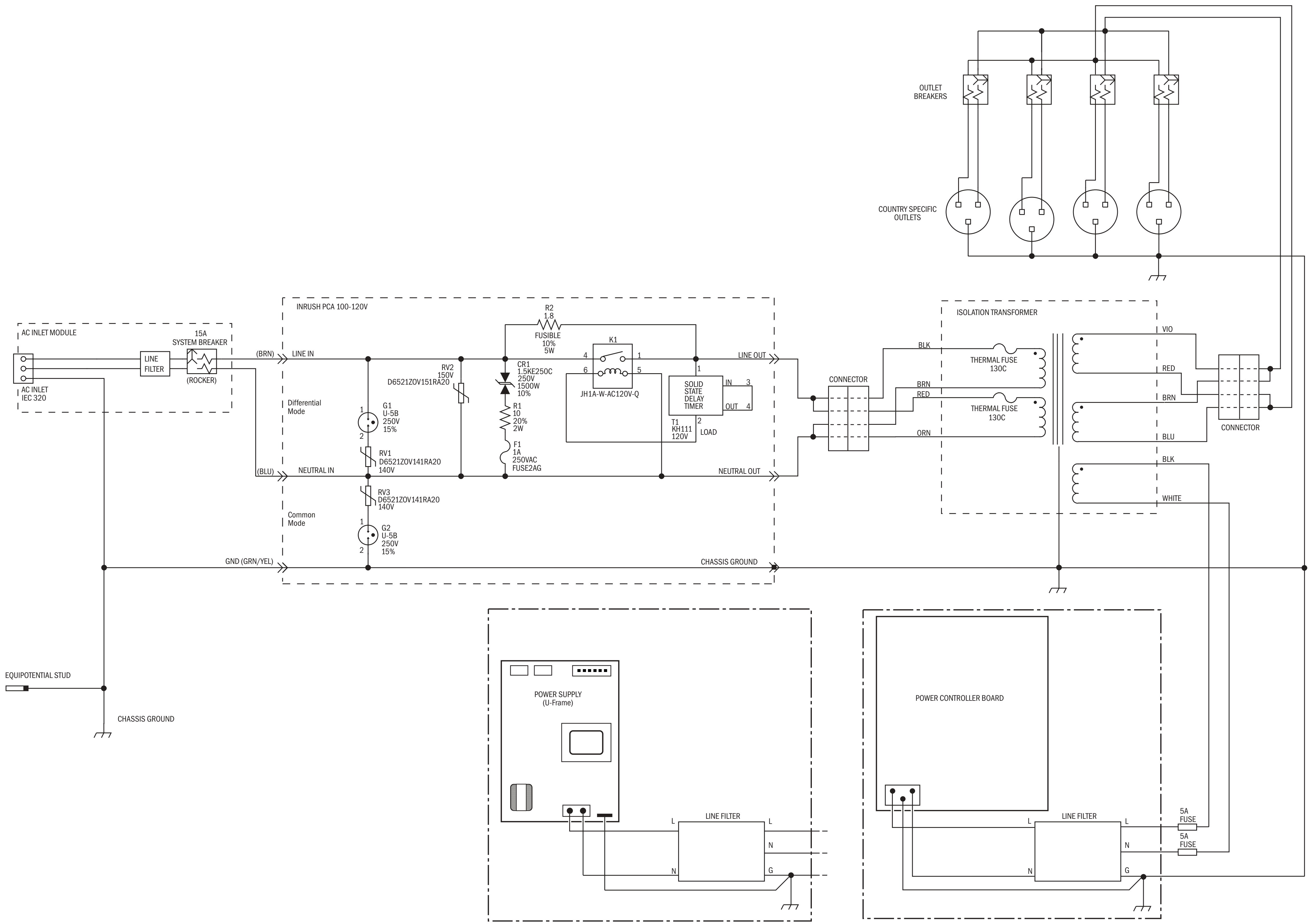


Figure 11-14 ▪ Schematic, AC Inlet module; 100–120 V (with isolated outlets)

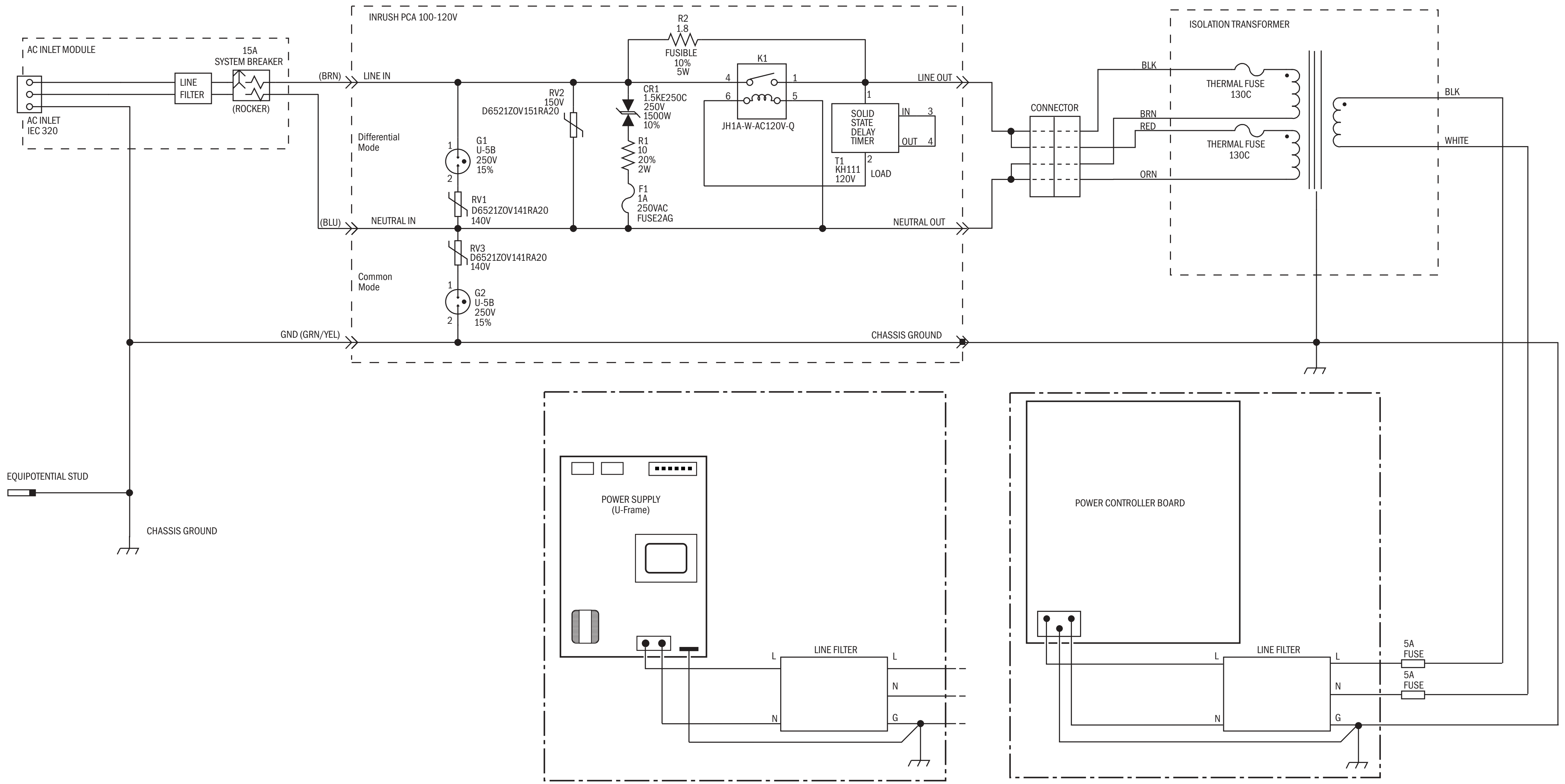


Figure 11-15 ▪ Schematic, AC Inlet module; 100–120 V (no outlets)

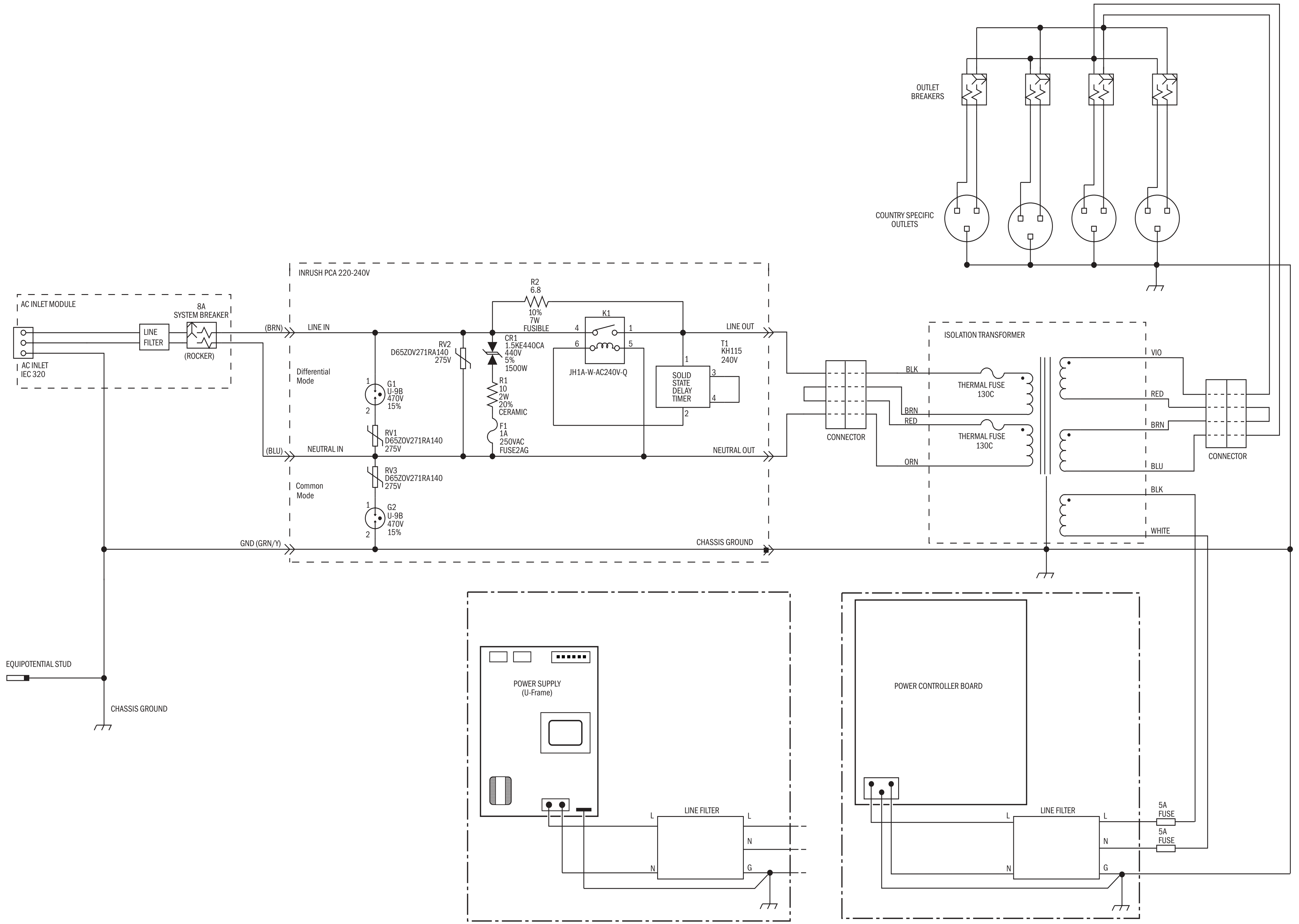


Figure 11-16 ▪ Schematic, AC Inlet module; 220–240 V (with isolated outlets)

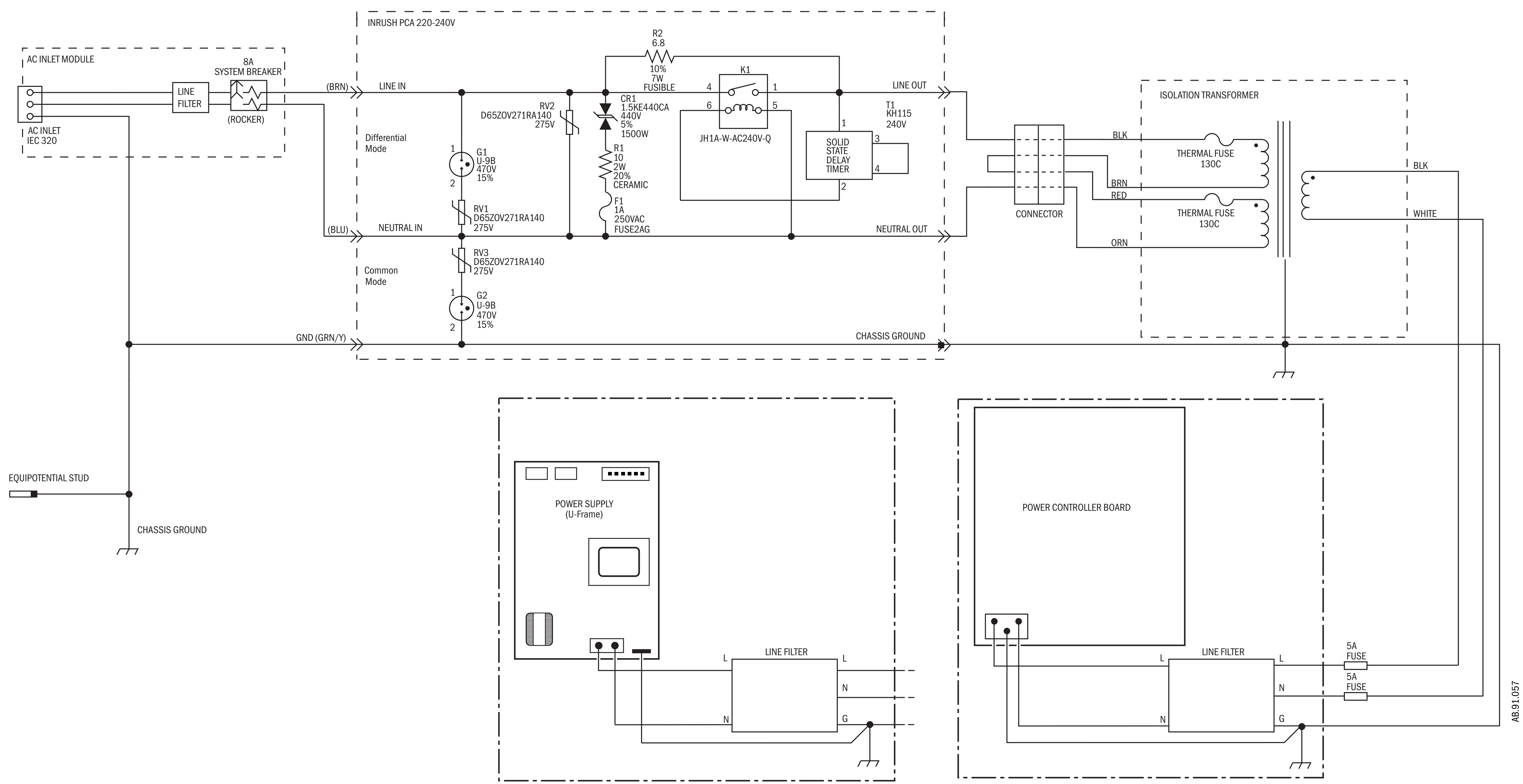


Figure 11-17 ▪ Schematic, AC Inlet module; 220–240 V (no outlets)

12 Service Application

In this section

12.1 Avance Service Application (PC based)

This section documents the Avance Service Application that runs on a Windows based computer and communicates with the high performance display unit (HPDU). It is compatible with Avance system software 5.0 or greater.

To enable communication with the Service Application, the Avance system must be in the Install/Service mode (or in a failed state provided the display unit is able to communicate).

The application can be used to diagnose electronically detectable failures in an Avance system.

Note This program is for machine diagnosis. It cannot be used for machine checkout or acceptance tests.

12.1.1 PC Requirements

Minimum requirements to run the application include:

- Personal computer using a Pentium 600 or higher microprocessor
- Windows 2000/XP
- 1024 by 768 resolution (or higher) video adapter
- Minimum of 128 MB of RAM, 256 MB recommended
- About 150 MB free hard disk space
- Microsoft-compatible mouse or equivalent device
- Serial Port or USB port with an RS-232 adapter

The PC used should meet the GE laptop standards. Screen resolution should be set to 96 dpi.

Port Setup

The Service Application communicates with the system through the serial port on the display unit (refer to section 2.4).

By default, the communication is channeled through the COM1 port on the PC.

Note: Ensure that no other application (such as PDA hot-sync) is using this port while the Service Application is running.

If other ports are available, you can select an available port in "Preferences" on the File menu (Section 12.5.1).

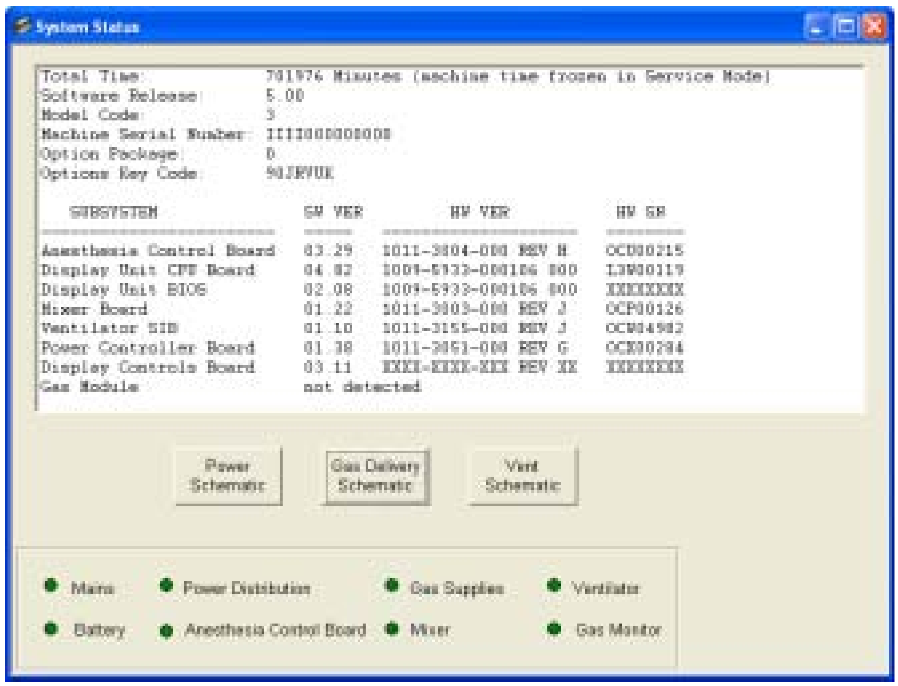
Startup Screen

Launching the Service Application opens the System Status screen. The startup screen establishes proper communications with the system.

12.2 Startup screen — System Status

If proper communication is established, the System Status screen displays the software and hardware revisions of various subsystems in the tested machine.

If there is a communication problem with the system, an error message is displayed and the connection is not completed.



A series of indicator lights at the bottom of the screen give an overall assessment of the system.

- a green bullet indicates proper operation of the subsystem.
- a red X indicates a failed condition in the subsystem.

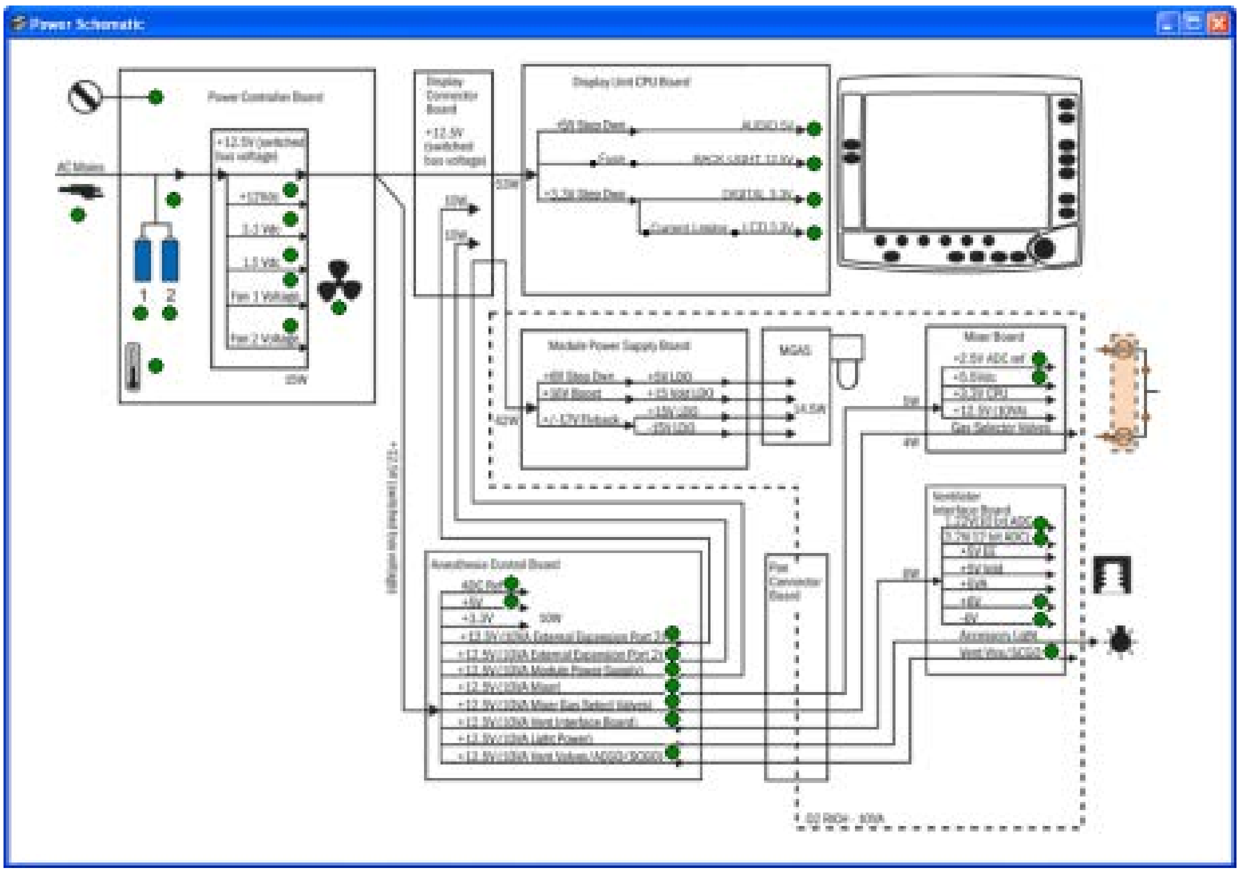
Schematics

The System Status screen includes three Softkeys that provide direct access to the schematical representation of a subsystem as shown in the following sections.

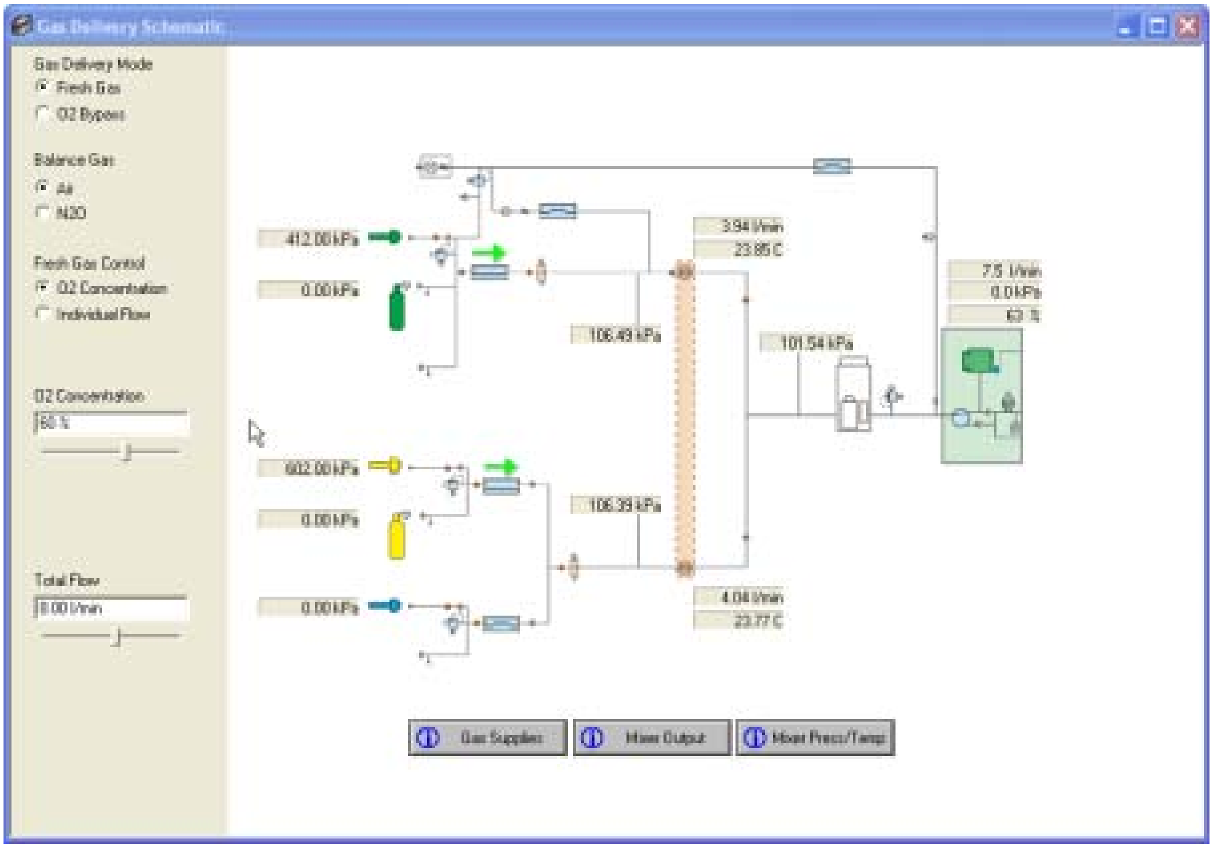
- The Power Schematic indicates the condition of power supplies throughout the system (*Section 12.3.1*).
- The Gas Delivery Schematic (*Section 12.3.2*)
  and the Vent Schematic (*Section 12.3.3*)
  include control devices that allow direct manipulation of components in the subsystem and displays the resulting output values for select downstream components.

12.3 System Schematics

12.3.1 Power Schematic



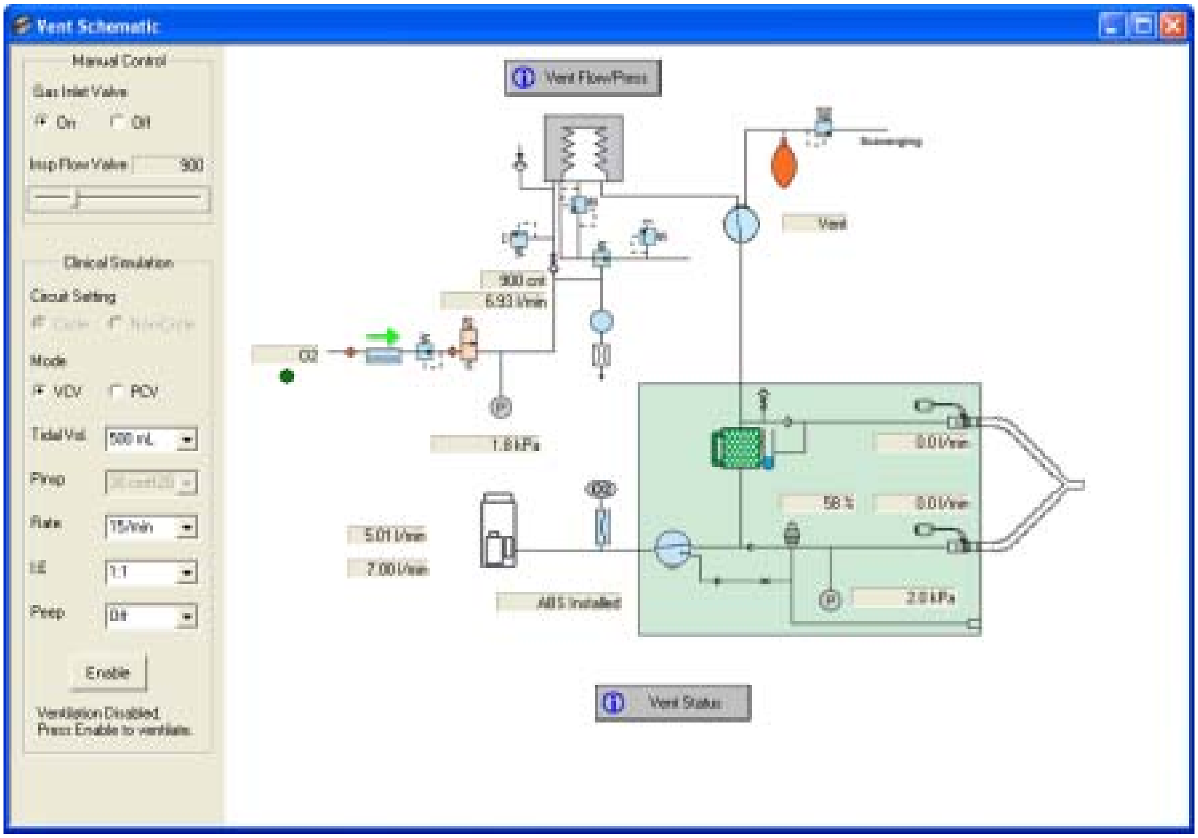
12.3.2 Gas Delivery Schematic



The Softkeys at the bottom of the Gas Delivery schematic bring up related diagnostic screens that are also accessible from the Gas Delivery Subsystem menu.

- ***Gas Supplies —*** (Section 12.8.1)
- ***Mixer Output —*** (Section 12.8.2)
- ***Mixer Press/Temp —*** (Section 12.8.5)

12.3.3 Vent Schematic



The Softkeys at the top and bottom of the Vent schematic bring up related diagnostic screens that are also accessible from the Vent Subsystem menu.

- ***Vent Flow/Press* —** (Section 12.9.2)
- ***Vent Status* —** (Section 12.9.1)

12.4 Menu Items

In addition to the schematic representations, the Service Application provides access to diagnostic screens through the following menu item structure.

File
(*Section 12.5***)**

- Preferences (*Section 12.5.1*)
- Exit

Tools
(*Section 12.6***)**

- Communication Status (*Section 12.6.1*)
- System Calibrations (*Section 12.6.2*)
- Transfer Logs (*Section 12.6.3*)

Power Diagnostics
(*Section 12.7***)**

- Power Schematic (*Section 12.3*)
- Power Board (*Section 12.7.1*)
- Anesthesia Control Board Power (*Section 12.7.2*)
- Mixer Board Power (*Section 12.7.3*)
- Vent Interface Board Power (*Section 12.7.4*)
- Display Unit Power (*Section 12.7.5*)

Gas Delivery Subsystem
(*Section 12.8***)**

- Gas Delivery Schematic (*Section 12.3.2*)
- Gas Supply Status (*Section 12.8.1*)
- Mixer Output (*Section 12.8.2*)
- Mixer Pressure and Temperature (*Section 12.8.3*)
- Gas Delivery Status (*Section 12.8.4*)
- Mixer Post/Checkout Test Results (*Section 12.8.5*)
- Perform Mixer Tests (*Section 12.8.6*)

Vent Subsystem
(*Section 12.9***)**

- Vent Schematic (*Section 12.3.3*)
- Vent Status (*Section 12.9.1*)
- Vent Flow and Pressure (*Section 12.9.2*)

Window
(*Section 12.10***)**

- standard “Window” manipulation items
- (list of all open windows)

Help
(*Section 12.11***)**

- About

12.5 File menu

The File menu includes the following menu items:

- Preferences (*Section 12.5.1*)
- Exit (quits the application)

12.5.1 File — Preferences

Selections on this screen affect the format of applicable values displayed on several of the diagnostic screens.

Unit Selection	
Label	**Value**
Gas Supply Pressure	kPa psi bar
Airway Pressure Units	cmH2O kPa hPa mmHg mbar
Temperature Units	Celsius Fahrenheit
Gas Color Code	ANSI ISO

Serial Port Selection

If the COM1 port is in use by another application, use the ***COM Port*** drop-down list on the **Serial Port Selection** screen to select an alternate COM port to use with the Service Application.

Port Selection	
COM Port:	COM1 -------- COM6

12.6 Tools menu

The Tools menu includes the following menu items:

- Communication Status (*Section 12.6.1*)
- System Calibration (*Section 12.6.2*)
- Transfer Logs (*Section 12.6.3*)

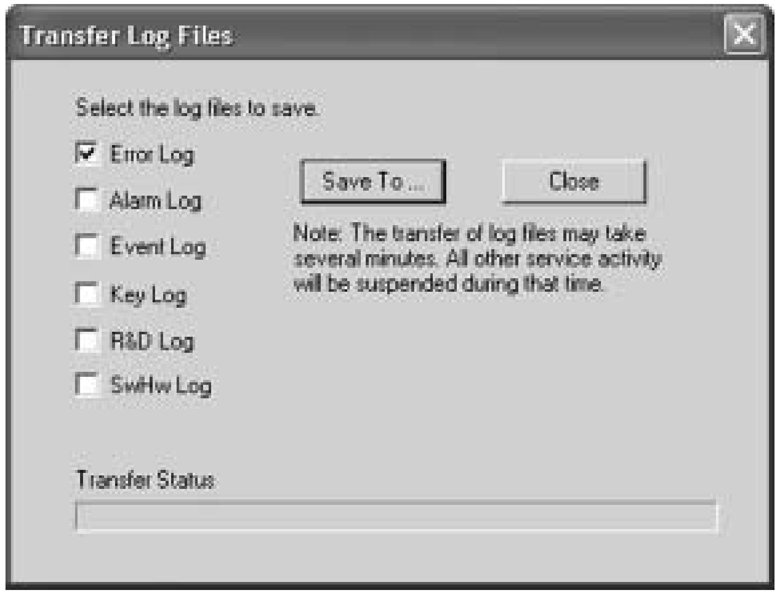
12.6.1 Tools — Communication Status

Communications Status	
Label	**Value**
Anesthesia Control Board	OK, Fail, ---
Mixer Board	OK, Fail, ---
Ventilator Interface Board	OK, Fail, ---
Power Controller Board	OK, Fail, ---
Controls (Front Panel) Board	OK, Fail, ---
Gas Module (MGas)	OK, Fail, not detected, ---
Link Status	No Link

12.6.2 Tools — System Calibrations

The System Calibrations screen displays the most recent date that the system passed a User or Service calibration or test.

12.6.3 Tools — Transfer Logs



12.7 Power Diagnostics menu

The Power Diagnostics menu includes the following menu items:

- Power Schematic (*Section 12.3*)
- Power Board (*Section 12.7.1*)
- Anesthesia Control Board Power (*Section 12.7.2*)
- Mixer Board Power (*Section 12.7.3*)
- Vent Interface Board Power (*Section 12.7.4*)
- Display Unit Power (*Section 12.7.5*)

12.7.1 Power Diagnostics — Power Board

Power Board			
Label	**Value Format**	**Units**	**Range**
12Vdc Supply	XX.XX	Vdc	11.70 to 12.30
3.3Vdc Supply	X.XXX	Vdc	3.201 to 3.399
1.5 Vdc Supply	X.XXX	Vdc	1.450 to 1.550
Battery Connected	Yes, No		
Calc Battery Time	XX	Min	00 to 30
Battery 1 Volts Battery 2 Volts	XX.X < 6.0 FAIL (red) <10 T Chg (yellow) 10-15.5 (Green)	Vdc	10.00 to 16.50
Battery Current	X.XXX	A	- 11.000 to 4.000
Battery Status	Fail Bulk Chg Over Chg Float Chg Trickle Chg On Discharge		
<*> Date battery Tested	--/---/----		
Last Full Discharge	XX	Min	
Board Temperature	<65C OK (green) >65C <75C Warn (Yellow) >75C Fail (red)	C F	max 64 max 147
Fan Speed	Slow, Fast		
Fan 1 Voltage	XX.XX	Vdc	10.08 - 10.92
Fan 1 Status	Low, High, Fail, OK		
Fan 2 Voltage	XX.XX	Vdc	10.08 - 10.92

<*> Date battery Tested = date of Last Full Discharge (refer to section 6.10).

12.7.2 Power Diagnostics — Anesthesia Control Board Power

Anesthesia Control Board Power

Label	Value	Units	Normal range
12 Vdc Supply	XX.XX	Vdc	11.90 to 12.90
ADC Ref	X.XXX	Vdc	4.018 to 4.176

Label	Value	Label	Value
Gas Select 10VA Volts	OK, Fail	Periph1 10VA Volts	OK, Fail
Gas Select 10VA Amps	OK, Fail	Periph1 10VA Amps	OK, Fail
Press Transducer 10VA Amps	OK, Fail		
		Periph2 10VA Volts	OK, Fail
Vent Interface Board 10VA Volts	OK, Fail	Periph2 10VA Amps	OK, Fail
Vent Interface Board 10VA Amps	OK, Fail		
Vent Valves 10VA Volts	OK, Fail		
Vent Valves 10VA Amps	OK, Fail		
Acces 1 10VA Volts	OK, Fail		
Acces 1 10VA Amps	OK, Fail		
Gas Unit 10VA Volts	OK, Fail		
Gas Unit 10VA Amps	OK, Fail		
Mixer 10VA Volts	OK, Fail		
Mixer 10VA Amps	OK, Fail		
Alt O2 10VA Volts	OK, Fail		
Alt O2 10VA Amps	OK, Fail		

12.7.3 Power Diagnostics — Mixer Board Power

Mixer Board Power			
Label	**Value Format**	**Units**	**Range**
Mixer 10VA Volts	OK, Fail		
12.5 V	XX.X	Vdc	11.8 to 13.0
5.5V	X.XX	Vdc	5.39 to 5.61
3.3V CPU	X.XX	Vdc	3.22 to 3.38
2.5V ADC Ref	X.XX	Vdc	2.47 to 2.53

12.7.4 Power Diagnostics — Vent Interface Board Power

Vent Interface Board Power			
Label	**Value Format**	**Units**	**Range**
Vent Board 10VA Volts	OK, Fail		
Vent Valves 10VA Volts	OK, Fail		
Vent Board 12.5V	XX.XX	Vdc	11.30 to 13.13
Vent Valves 12.5V	XX.XX	Vdc	11.30 to 13.13
3.2 Vdc (12bit Vref)	X.XXX XXXX	Vdc Counts	3.179 to 3.221
1.22 Vdc (10bit Vref)	X.XXX XXXX	Vdc Counts	1.074 to 1.367
+6.0Vdc	X.XX	Vdc	5.51 to 6.50
-6.0Vdc	-X.XX	Vdc	-6.72 to -5.28

12.7.5 Power Diagnostics — Display Unit Power

High Performance Display Unit (HPDU)

Display Unit Power			
Label	**Value Format**	**Units**	**Range**
LCD backlight 12.5V	XX.XX	Vdc	10.50 to 14.00
Audio 5V	X.XX	Vdc	4.50 to 5.50
Digital 3.3V	X.XX	Vdc	2.97 to 3.63
LCD 3.3V	X.XX	Vdc	2.97 to 3.63
LCD Inverter B output	X.XX	Vdc	0.00 to 1.30
LCD Inverter A output	XX.XX	Vdc	0.00 to 1.30

12.8 Gas Delivery Subsystem menu

The Gas Delivery Subsystem menu includes the following menu items:

- Gas Delivery Schematic (*Section 12.3.2*)
- Gas Supply Status (*Section 12.8.1*)
- Mixer Output (*Section 12.8.2*)
- Mixer Pressure and Temperature (*Section 12.8.3*)
- Gas Delivery Status (*Section 12.8.4*)
- Mixer Post/Checkout Test Results (*Section 12.8.5*)
- Perform Mixer Tests (*Section 12.8.6*)

12.8.1 Gas Delivery Subsystem — Gas Supply Status

Gas Supply Status

Label	Value Format	Range (kPa)	Range (psi)	Range (bar)
O2 Cylinder 1	XXXXX.XX	0.00 to 27580.00	0.00 to 40000.14	0.00 to 275.80
O2 Cylinder 2	XXXXX.XX	0.00 to 27580.00	0.00 to 40000.14	0.00 to 275.80
Air Cylinder	XXXXX.XX	0.00 to 27580.00	0.00 to 40000.14	0.00 to 275.80
N2O Cylinder	XXXX.XX	0.00 to 9805.00	0.00 to 1422.10	0.00 to 98.05
O2 Pipeline	XXX.XX	0.00 to 697.00	0.00 to 101.09	0.00 to 6.97
Air Pipeline	XXX.XX	0.00 to 697.00	0.00 to 101.09	0.00 to 6.97
N2O Pipeline	XXX.XX	0.00 to 697.00	0.00 to 101.09	0.00 to 6.97
O2 Select Valve	Open, Closed (Open = connected to Mixer)			
Air Select Valve	Open, Closed (Open = connected to Mixer)			
N2O Select Valve	Open, Closed (Open = connected to Mixer)			
Alt O2 Valve	Open, Closed (Open = O2 bypass)			
Alt O2 Button	Not Pressed, Pressed			
O2 Flush	Not Pressed, Pressed			
Gas Outlet Config.	Circle, SCGO, ACGO			

12.8.2 Gas Delivery Subsystem — Mixer Output

Mixer Output			
Label	**Value**	**Units**	**Range**
O2 Flow	XX.XX	l/min	0.00, 0.10 to 15.75
O2 Flow Verify	XX.XX	l/min	2.00 - 18.00
O2 Flow Signal	X.XXXX	Vdc	0.0986 to 4.0100
O2 Prop Valve Drive	XXX	mA	0, 29 to 138
Balance Gas ID	None, Air, N2O		
Balance Flow	XX.X	l/min	0.1 - 15 for Air 0.1 - 12 for N2O
Balance Flow Verify	XX.X	l/min	2 - 18 for Air 2 - 14.4 for N2O
Balance Flow Signal	X.XXX	Vdc	0.050 to 4.045 Vdc
Balance Prop Valve Drive	XXX	mA	0, 29 to 138
O2 Select Valve	Open, Closed		
Air Select Valve	Open, Closed		
N2O Select Valve	Open, Closed		
ADC Ref Voltage	X.XX	Vdc	2.47 to 2.53

12.8.3 Gas Delivery Subsystem — Mixer Pressure and Temperature

Mixer Pressure and Temperature					
Label	**Value**	**Units**	**Range (kpa/C)**	**Range (psi/F)**	**Range (bar/C)**
O2 Pressure	XX.XX		62.05 to 220.63	9.00 to 32.00	0.62 to 2.21
O2 Pressure Cal	X.XXX	Vdc	0.55 to 2.90	0.55 to 2.90	0.55 to 2.90
Balance Pressure	XX.XX		62.05 to 220.63	9.00 to 32.00	0.62 to 2.21
Balance Pres Cal	X.XXX	Vdc	0.55 to 2.90	0.55 to 2.90	0.55 to 2.90
Mixer Output Pres	XX.XX		62.05 to 199.95	9.00 to 29.00	0.62 to 2.00
Mixer Output Pres Cal	X.XXX	Vdc	0.55 to 2.90	0.55 to 2.90	0.55 to 2.90
O2 Temp	XX.X		5.00 to 50.00	41.00 to 122.00	5.00 to 50.00
O2 Temp Volts	X.XXX	Vdc	0.25 to 3.00	0.25 to 3.00	0.25 to 3.00
Balance Temp	XX.X		5.0 to 50.0	41.0 to 122.0	5.0 to 50.0
Balance Temp Volts	X.XXX	Vdc	0.25 to 3.00	0.25 to 3.00	0.25 to 3.00

12.8.4 Gas Delivery Subsystem — Gas Delivery Status

Gas Delivery Status			
Label	**Value**	**Units**	**Range**
O2 Flow	XX.XX	l/min	0.00, 0.10 to 15.75
Air Flow	XX.XX	l/min	0.00, 0.10 to 15.75
N2O Flow	XX.XX	l/min	0.00, 0.10 to 12.60

12.8.5 Gas Delivery Subsystem — Mixer Post/Checkout Test Results

Mixer Post/Checkout Test Results	
Label	**Test Results**
Alt O2 Valve Leak	Pass not performed (if O2 Valve Leak fails) Not done. No supply pressure Not done. Selector valve incorrect state Fail. Selector valve leaks Fail. Proportional valve leaks
O2 Valve Leak	Pass Fail. O2 Bypass valve leaks
Balance Gas Valve Leak	Pass Not done. No supply pressure Not done. Selector valve incorrect state Fail. Selector valve leaks Fail. Proportional valve leaks
O2 Flow Test	Pass Not done. No supply pressure Not done. Selector valve incorrect state Fail, 3 LPM test failed Fail, 10 LPM test failed
Balance Flow Test	Pass Not done. No supply pressure Not done. Selector valve incorrect state Fail, 3 LPM test failed Fail, 10 LPM test failed

12.8.6 Gas Delivery Subsystem — Perform Mixer Checkout Tests

Selecting ***Perform Mixer Checkout Tests*** brings up the following screen. This screen includes and automatic and a manual leak test of the Mixer's balance gas inlet check valves.

Automatic

The ***BalGas Check Valve Leak Test Auto*** does not require disassembly of the system. It is a sensitive test that will Pass check valve that have leak rates within specifications; however, it may Fail some Mixers with marginal but acceptable leak rates.

- Mixers that Pass the auto leak test do not require further testing and can be left in service.
- Mixers that Fail the auto leak test should be further tested using the manual leak test.

Manual

The ***BalGas Check Valve Leak Test Manual*** requires disassembly of the system.

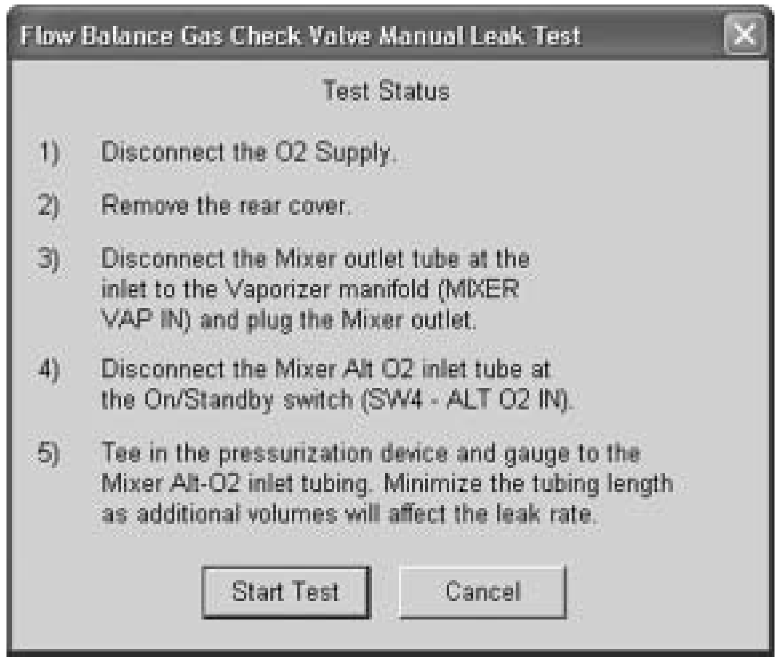
- Mixers that Pass the manual leak test have acceptable leak rates and can be left in service.
- Mixers that Fail the manual leak test should be replaced.

Automatic leak test

1. Connect an O_2 supply.
2. Select ***Start Test*** to perform the ***BalGas Check Valve Leak Test Auto***.
    - If Pass, balance gas check valve leak rate is acceptable.
    - If Fail, verify leak rate using the manual leak test.

Manual leak test

Selecting ***BalGas Check Valve Leak Test Manual*** brings up the manual leak test setup instructions.



Select ***Start Test*** to perform the manual leak test as follows.

1. Slowly pressurize the Mixer to 400 mmHg (over a 5-second period), as read on the test device.
2. The pressure shown on the test gauge should not decrese to zero in less than 10 seconds.
3. Select ’End Test’ when done.

After completing the test:

1. Remove all test fixtures.
2. Re-assemble Mixer pneumtics and remove plugs from Mixer assembly.
3. Re-attach Oxygen supply and activate ’Confirm’.

12.9 Vent Subsystem menu

The Vent Subsystem menu includes the following menu items:

- Vent Schematic (*Section 12.3.3*)
- Vent Status (*Section 12.9.1*)
- Vent Flow and Pressure (*Section 12.9.2*)

12.9.1 Vent Subsystem — Vent Status

Vent Status	
Label	**Value**
Vent Drive Gas	Air or O2
ABS Installed	Installed or Not Installed
Flush Valve	Not Pressed or Pressed
<*> CO2 Bypass	Closed or Open
O2 Cell Status	Connected or None
Bag/Vent Switch	Bag or Vent
Circuit Feedback	Circle, Non-circle, or fault
Over Pressure Circuit	OK or High-Pressure
ACGO/SCGO Config	ACGO or SCGO
Gas Inlet Valve Feedback	Open or Closed

<*> This refers to the Canister Release switch. The value defaults to Closed if the switch kit is not installed (refer to section 10.21).

12.9.2 Vent Subsystem — Vent Flow and Pressure

Vent Flow and Pressure

	Menu Item	Value	Units	Range	Counts (0-4095)
	Inspiratory Flow	XXX.X	l/min	-120.0 to 120.0	XXXX
	Expiratory Flow	XXX.X	l/min	-120.0 to 120.0	XXXX
<*>	Airway Pressure	XX X	cmH_2O	-20.0 to 120.0	XXXX
<*>	Manifold Pressure	XXX	cmH_2O	-20.0 to 120.0	XXXX
	O2 Cell	XXX	%	5 to 110 %	XXXX
	ADC Ref Voltage	X.XXX	Vdc	3.179 to 3.221	
	Flow Valve Setting	XXX.X	l/min	0.00 to 140.00	XXXX
	Flow Valve Feedback	xxxx	mV	0 to 4095	XXXX
	Flow Valve Current	xxxx	mA	0.0 to 102.4	XXXX

<*>	kPA	-2.0 to 11.8
	hPA	-19.6 to 117.7
	mmHg	-14.7 to 88.3
	mBar	-19.6 to 117.7

12.10 Window menu

The Window menu includes the following menu items:

- Cascade
- Tile Horizontal
- Tile Vertical
- Close
- Close All
- (list of all open windows)

12.11 Help menu

The Help menu includes the following menu items:

About...

About

Avance Anesthesia System
Technical Reference Manual

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